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April, 1914.

Entomological Series.

THE ROYAL CANADIAN INSTITUTE
Vol. V, No. I.

Biological
& Medical
Serials

Memoirs of the Department of Agriculture in India

STORAGE

LIFE-HISTORIES OF INDIAN INSECTS—V

LEPIDOPTERA. (Butterflies)

BY

C. C. GHOSH, B.A.

Assistant to the Imperial Entomologist



AGRICULTURAL RESEARCH INSTITUTE, PUSA

PRINTED AND PUBLISHED FOR

THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

BY

THACKER, SPINK & CO., CALCUTTA

W. THACKER & CO., 2, CRESS LANE, LONDON

Price, Rs. 2-8 or 3s. 9d.

APR 25 1921

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PREFACE


This Memoir contains information which has been accumulating for some years and includes accounts of life-histories of practically all the butterflies which are of economic importance in India. The observations have been carried out in the Pusa Insectary under the direction of the Imperial Entomologist. The account of the Rice Leaf Caterpillar (*Melanitis ismene*) was written some time ago by Mr. H. Maxwell-Lefroy, formerly Imperial Entomologist, but was not published and is included in this Memoir. In writing the account of the Cabbage White the notes of Mr. R. D. Koppikar have been used.

A. J. GROVE,

Offg. Imperial Entomologist.

PUSA,

September 18th, 1913.



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LIFE-HISTORIES OF INDIAN INSECTS--V.

LEPIDOPTERA (Butterflies).

BY

C. C. GHOSH, B.A.

Assistant to the Imperial Entomologist.

INTRODUCTION.

THE insects, the life-histories of which are described in this volume, are representatives of the principal families of that interesting group of insects, the Butterflies. With the exception of one (*Delias*) the others are pests of more or less economic importance, occurring on trees and plants either cultivated or grown for the garden. All are of interest and importance in that they are probably the first to attract the attention of the beginner in Entomology, especially Economic Entomology. Also they occur so constantly and are so common that in all their stages, they frequently come under the notice of even the common people, but for want of a proper knowledge and observation ordinary people fail to see the connection between the caterpillar which eats the leaves, the dormant pupa and the butterfly which incessantly flies about under trees, over bushes and plants and not infrequently in houses or even over one's head. The hanging Nymphalid, Papilionid and Pierid pupæ are frequently mistaken for fruits by many. For the progress of Economic Entomology in India it is essential that the people should become familiar with the insects and especially with their life-history. The greatest bar to progress in checking injurious insects here is the fact that a mysterious origin is usually assigned to them, simply because the elementary and essential facts of insect transformations are not known to those who suffer from the depre-

dations of the insects. The life-history of the insects described in this volume is easily observed. The caterpillars thrive in captivity, requiring only a daily supply of fresh leaves until they pupate. The stages figured in the plates are easily seen. For this reason any one of these insects can be recommended as an object-lesson to teachers.

Under each insect the recent literature is quoted, where the reader will find references to the systematic literature dealing with it. The reader is also referred to the account of the common butterflies of the plains of India appearing in the Journal of the Bombay Natural History Society, Vol. XIX *et seq.*, where Mr. T. R. Bell has given new descriptions of almost all the species dealt with in this volume.

PLATE I.



RICE LEAF CATERPILLAR.

MELANITIS ISMENE, Cr.

THE RICE LEAF CATERPILLAR.

(PLATE I).

[Bingham, Fauna of India, Butterflies, Vol. I, 1905, p. 158.]

Distribution.—Africa, Madagascar, Mauritius, Bourbon. Indo-Malayan region to Australia. In India, common in Bengal, Central and Peninsular India; also in Assam, Burma, Ceylon, rare in the Punjab and Himalayas, common in the United Provinces (de N.).

Broods.—The complete life-cycle of one batch is as follows:—Eggs laid on the 3rd October, hatched 6th October, larvæ pupated 28th and 29th October, butterflies emerged 8th and 9th November; this gives a total of 36 to 37 days from egg to imago. There is a brood that emerges as butterflies in August-September, presumably the “Wet-season” form; these lay eggs in October and emerge in November and live over until July or breed earlier if food is available.

Food-plants.—Rice (*Oryza sativa*) is a common food-plant, though the larvæ rarely occur on it in any abundance in one place. Juar (*Andropogon sorghum*) is another. Moore says that it generally “feeds on grasses.”

Life-history—The egg.—The butterfly lays eggs on the lower surface of the leaf of the food-plant, one or a few eggs at a time, usually in a row, the eggs close together (Plate I, fig. 1). Eggs are laid during the day, the butterflies being inactive at night. In the Insectary great difficulty was experienced in getting eggs at all and the number normally laid in the open has not been ascertained.

Each egg is spherical with a flattened base, smooth, without any ornamentation; it measures about 1 mm. in diameter; the

colour is creamy white when first laid, but before hatching a black spot appears at the apex, marking the head of the caterpillar within. Eggs hatched within three days from the time of deposition; the emergence of the caterpillar takes place through a hole it gnaws in the shell after which the remainder of the empty shell is wholly or partly eaten.

The larva.—The newly-hatched larva is about 2 mm. long; the head is black, larger in section than the body and with the long axis vertical; the processes characteristic of the later stages are scarcely perceptible. The body is cylindrical, white with a faint green tinge, becoming green in the course of the first day. The five pairs of prolegs are fully developed and the processes at the hind end are perceptible though very small.

On hatching and after having eaten the egg-shell, leaving as a rule only the base which is fastened to the leaf, the larvæ remain motionless on the rice-leaf; their attitude is always the same, the body parallel to the midrib and close to it; when several are on one leaf they rest close together one behind the other; at intervals they feed on the edge of the leaf and they remain on the leaf until the first moult is passed. Throughout larval life the habits vary little; the green larva rests on the underside of the leaf, parallel to the midrib, lying along the narrow rice or grass-leaf; the colouring, attitude and habits are cryptic, designed to conceal the larva and figure 4 in Plate I illustrates clearly how markedly cryptic this is. During the day, larvæ move little and they feed more at night; feeding is done at intervals during the day especially by young larvæ; from above one sees only the black head appearing at the margin and it is difficult to find larvæ in the field except by looking for bitten leaves.

There are five larval moults, the last revealing the pupa; feeding ceases for a day before moulting as is usual in caterpillars; the integument of the body is shed quickly and easily, the head-case being shed separately and apparently with greater difficulty. The head is green after the moult. The larva feeds by bending

over to the margin of the leaf till it is able to bite from the edge inwards; it eats into the midrib in many cases, but as its head has little play, the body remaining fixed, the eaten leaf is very characteristic, curved pieces being eaten out of each side as far as the midrib (Plate I). Young larvæ remain together on one leaf and rest only on the middle; older larvæ scatter, and may fix themselves near the margin and so be able to feed more easily; full-grown larvæ eat the midrib also. The following are the dates of the moults:—Two larvæ hatched 6th October, first moult 9th, second moult 12th, third moult 15th, fourth moult 20th, final moults 28th and 29th. The instars may be shortly described as follows:—

First instar.—Length 4 mm. Head deep-brown to black, the front vertical, the circumference greater than that of any segment. The processes are small, yellow and covered with black spines. Body cylindrical, segments distinct, each segment with transverse wrinkles; a few long hairs on each segment, as well as many short white hairs on white tubercles. The anal processes project directly behind the body, greenish in colour with short black spines.

Second instar.—Length 6 mm. Side of the head and mouthparts yellowish. Head processes black, longer, thicker and with a yellow knob. A dorso-lateral white stripe runs from the prothorax to the hind end; the white tubercles are more marked.

Third instar.—Length 9 mm. Head black, green round the mouthparts, with a triangular green space on the frons, the sides green with a white line along each cheek; the processes black. The body shows a broad mid-dorsal green stripe, bordered by an indistinct white line; the white dorso-lateral stripe is broader and below the spiracles, there is a faint yellowish line. The white tubercles are prominent giving the body a speckled appearance. (Plate I, fig. 3).

Fourth instar.—Length 14 mm. Body thicker at and behind the fourth abdominal segment. Head green, mouthparts dark brown: there is a lateral white band stretching from the base of the processes to the mouthparts which is in some specimens bordered with black, in others continued on the processes which are then brown in front, white behind.

Fifth instar.—Length 30 mm. at first, increasing to 45 mm. Head green with a broad lateral white stripe, often bordered with black: processes red-brown; both head and processes are covered in thin black and grey hairs. Body tapering markedly from the fourth abdominal segment (6 mm. across) to the

prothorax (3 mm. across) ; the segments are less distinct, the white tubercles form irregular interrupted lines and there are seven transverse wrinkles to each segment. The anal processes are green, with black hairs. The spiracles are oval, black rimmed ; the legs and prolegs green.

Throughout larval life the colouring, form and attitude are cryptic and this is carried out in small details ; the dark head of the younger stages and the processes on the head alone appear to be incompatible with this object ; the body tapers off behind very gradually into the anal processes which lie flat on the leaf ; there is no marked rounding off behind which would throw a marked shadow, and the clothing of white and black hairs probably aids in softening shadows and masking the definite outlines of a curved solid body. The more marked lateral white stripes in the younger stages give place to the more indefinite broken lines in the larger insect, both being probably effectual in rendering the larva inconspicuous.

The pupa.—The full-fed larva spins a small network of silk on the underside of a leaf and then hangs head down by the anal prolegs, the body curving inwards ventrally (Plate. I , fig. 5). In this attitude it rests for 16 to 20 hours ; the body is then stretched till it is almost straight, the skin bursts along the mid-dorsal thoracic line and the end of the pupa appears through the split ; the larval head case then splits along the vertex and the front half of the larval skin slips back, leaving the thoracic half of the pupa free ; the ruptured larval skin then slides backwards over the pupa till it only surrounds the abdomen of the pupa ; the extreme anal apex of the pupa is then brought out of this skin and is struck into the net woven by the larva, the curved hooks on the apex engaging in the silk and, by a twisting of the pupa, getting firmly twisted in the fibres ; for one brief instant then the pupa would appear to have no support (between the emergence of the apex of the abdomen and its engaging in the silk), but actually the pupa is during this instant suspended by two knobs on the penultimate anal segment, which are curved forwards, away from the apex of the abdomen, and which engage in the larval skin as it

slips backwards and so arrest the fall of the pupa long enough for it to strike the apex of its abdomen into the silk and twist itself round. The larval skin is then free and, the contraction of the anal prolegs no longer fastening it to the leaf, it falls away leaving the pupa hanging (Plate I, fig. 6). The above action occupies only a few seconds. The pupa is about 21 mm. long, 8 mm. across, the stalk at the apex of the abdomen about 1.5 mm. long. There are seven pairs of spiracles; the developing eyes, wings, legs and antennæ are clearly distinguishable in the later stages of pupation. The pupal period is about 10 days.

The imago.—Emergence of the imago takes place by the rupture of the pupa-case along the position of the antennæ (Plate I, fig. 7). The butterflies emerge, cling to the pupa-case till its wings are spread and hardened, which takes place in one to two hours. The butterflies are diurnal, and are found commonly flying about the trunks of large trees and settling on the ground below them; they frequent only shady places and may be seen flying actively and playing together in such places.

ERGOLIS MERIONE, CRAM.

THE CASTOR SPINY CATERPILLAR.

(PLATE II).

[Bingham, Fauna of India, Butterflies, Vol. I, 1905, p. 162.]

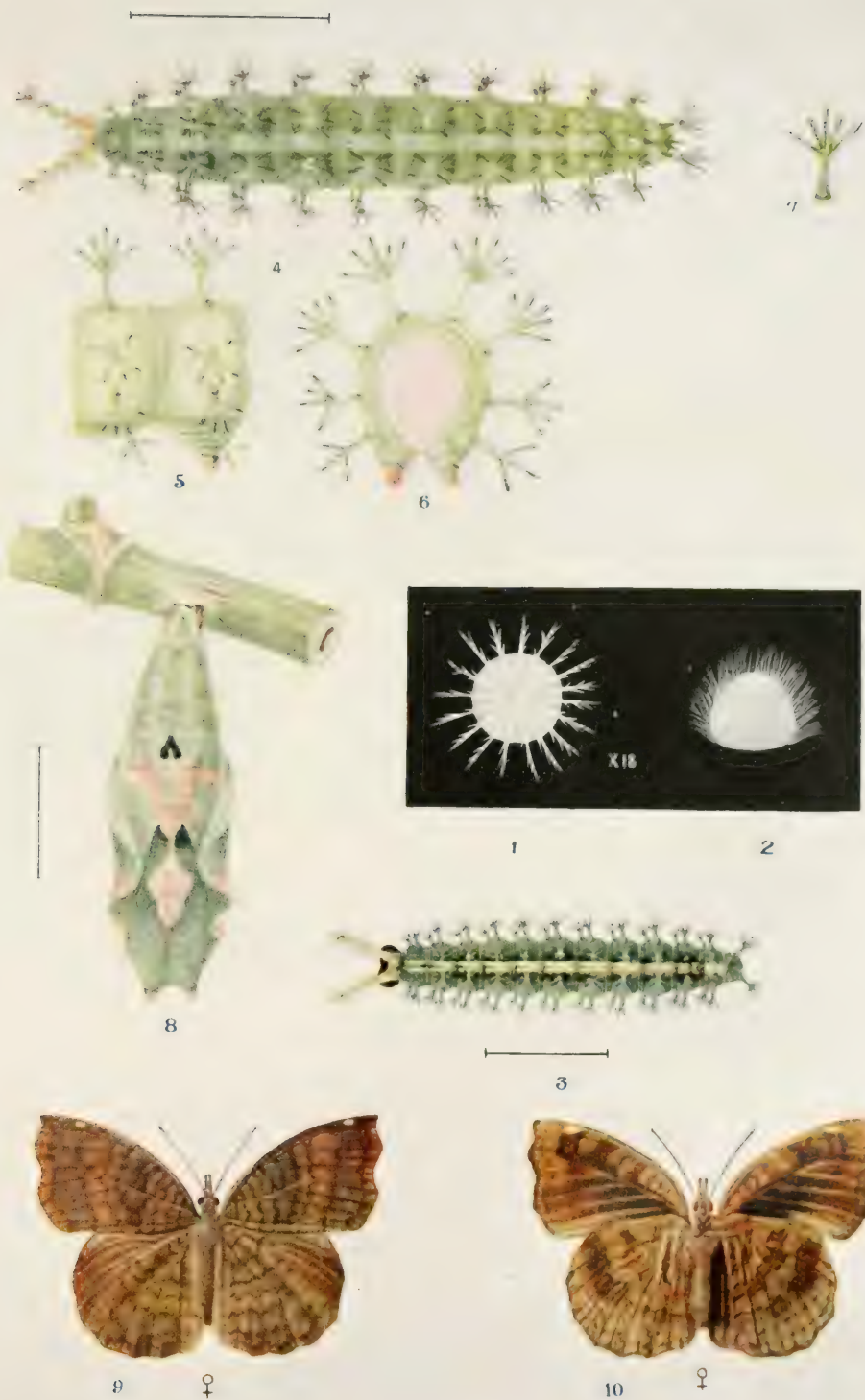
Bingham takes Westwood's *E. taprobana* as the Southern Indian and Ceylon race of *E. merione*, but it is evidently a distinct species and is not a castor-feeder at all (T. B. F.) Moore's *E. tapestrina* is taken by de Niceville as an aberration or sport of *E. merione* and Bingham agrees with him.

Distribution. (*E. merione*).—The northern half of Continental India, Simla to Sikkim in the Himalayas, and recorded from Rajputana and Bengal; Assam, Burma, Tennasserim, Malayan Sub-region. (*E. taprobana*). Southern India, Ceylon. (Bingham).

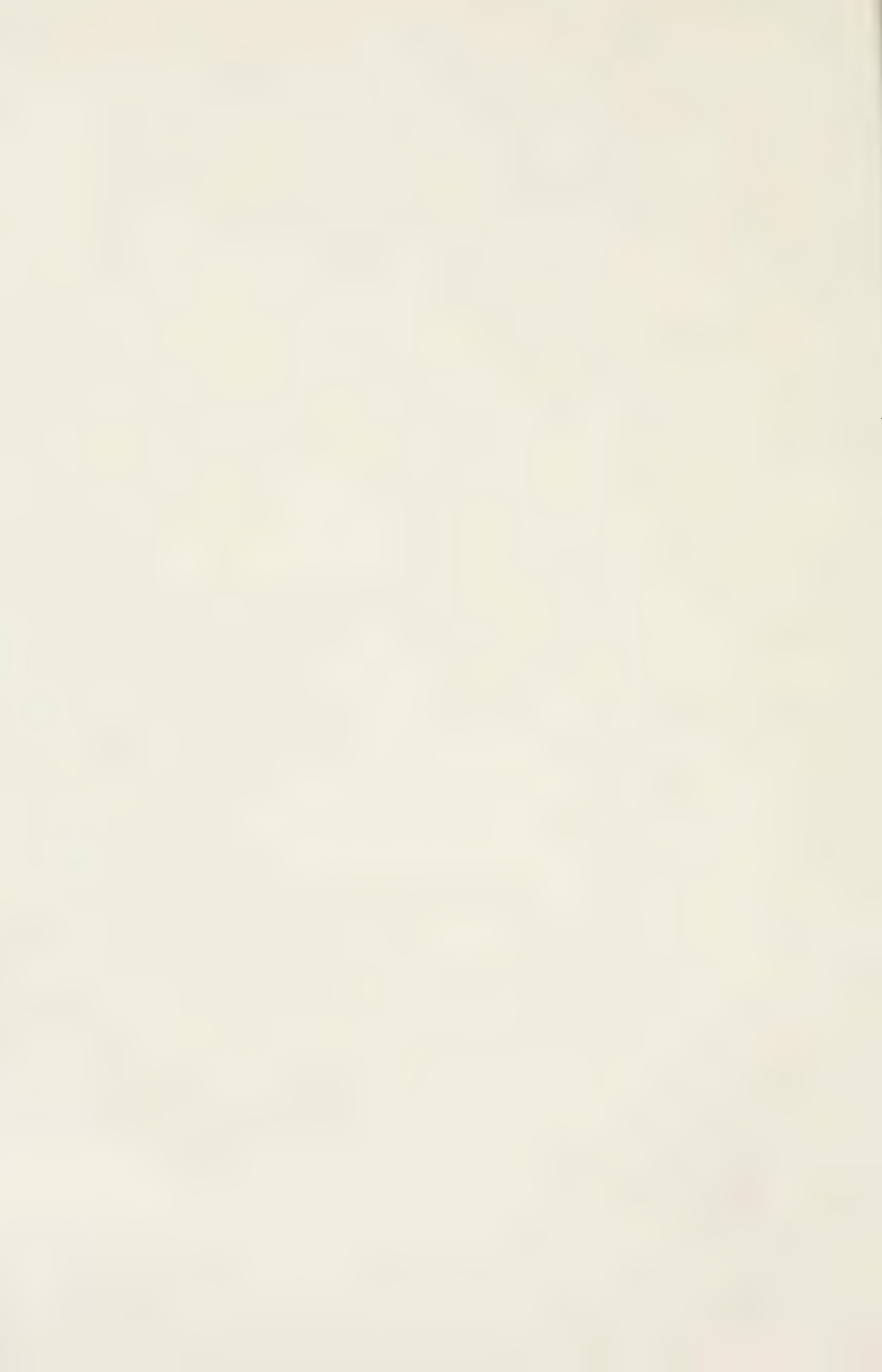
Food-plant and damage.—The larva feeds on castor (*Ricinus communis*) leaf. It is a minor pest and there seems to be hardly any likelihood of its turning into a serious one.

Life-cycle.—*Ergolis merione* is active throughout the year. There is no actual hibernation, but as will be evident from the table given below, the periods of the different stages are lengthened in the cold weather so that the life-cycle in winter is about three times as long as in the warmer weather.

Egg laid.	Egg hatched.	Larva pupated.	Butterfly emerged.	Periods in days.
18 Aug.	21 Aug.	31 Aug.	7 Sept.	3 + 10 + 8 = 21
19 "	22 "	31 "	7 "	3 + 9 + 8 = 20
20 "	23 "	4 Sept.	11 "	3 + 12 + 7 = 22
14 Sept.	17 Sept.	27 "	2 Oct.	3 + 10 + 5 = 18
14 "	17 "	27 "	3 "	3 + 10 + 6 = 19
15 Nov.	20 Nov.	25 Dec.	14 Jany.	5 + 35 + 20 = 60
15 "	20 "	26 "	17 "	5 + 36 + 22 = 63
25 "	1 Dec.	1 Jany.	25 "	6 + 31 + 24 = 61



THE CASTOR SPINY CATERPILLAR.



The egg.—The butterfly deposits eggs singly on the under-surfaces of leaves, sometimes but much less commonly on their upper surfaces and rarely on the petioles. The butterflies being diurnal in habit, eggs are laid only during the day time. It is very difficult to make the butterflies breed in confinement. In the Insectary eggs were obtained from only one female which emerged on 14th September, mated in the afternoon of the 17th and laid 36 eggs, *viz.*, seven in the afternoon of the 18th, twenty-three in the morning of the 19th, and six in the same afternoon; she died the same night. Of these eggs only three were deposited on the upper surfaces of leaves, the remainder being on the lower surfaces. Each egg (Plate II, figs. 1 & 2) is dome-shaped with a flattened base and measures about $\frac{1}{2}$ mm. vertically and is about $\frac{2}{3}$ mm. from side to side, the diameter of the flattened base being about $\frac{1}{2}$ mm. From the periphery of the micropylar depression at the top of the egg, ridges and furrows run down the sides in regular order. The ridges vary in number from eighteen in some to twenty in others and are surmounted with long thin hairs, the furrows and the micropyle being free. The egg, therefore, looks hairy; figure 1 represents it as seen directly from above and figure 2 from the side. The colour of the egg with the hairs is uniform white. The eggs take about three days to hatch in summer temperature and six days or more in winter. The young caterpillar emerges by gnawing a hole in the shell and then eats it either partly or wholly; sometimes the portion of the leaf on which the base of the egg is fastened is also eaten, a small hole being produced in the leaf.

The larva.—After hatching from the egg the larva lives and feeds on the leaves of the plant until it is ready to pupate. It either bites holes in the middle of the leaf or eats from the edge. It feeds both during the day time and at night and is in the habit of taking rest occasionally and not eating continuously like many other caterpillars. Hence it produces holes here and there in the leaf and never reduces it to mere skeleton of veins like the semilooper caterpillar (*Ophiura melicerte*). It often rests on the upper

surface of the leaf just above the junction with the petiole and on the spot whence the big veins arise. It rests in a peculiar attitude, the middle of the body being partly looped up and the hind end somewhat raised in the air. When it rests in this position the broad yellow stripe in the middle of its green back usually coincides with one or other of the big broad veins which too are of a lighter colour than the surface of the leaf. Not infrequently again the caterpillar will be found to sit similarly on a vein on the upper surface of the leaf, so that the stripe on its back appears in a line with the vein. Although this habit strikes one as peculiar, the larva may not uncommonly be found anywhere on the leaf either on its upper or lower surface. After hatching from the egg the larva passes through five moults pupating at the last. The following are the records of moults of two larvæ kept under observation :-

Hatched.	1st moult.	2nd moult.	3rd moult.	4th moult.	5th moult.
28th July 23rd Aug.	30th July 26th Aug.	1st Aug. 28th Aug.	3rd Aug. 30th Aug.	5th Aug. 1st Sept.	7th Aug. 4th Sept.

The process of casting off the first four moults is different from that of the fifth, in that the head moult is cast off separately in the former ; the several hours of rest before the skin is shed are taken up mainly in extricating the head and then the skin is slipped off the body within about a minute, the moult of the head being also rubbed off at the same time. The larva moves forward a little from the rejected skin which sticks to the place, and after about half-an-hour's rest turns round and eats the cast skin completely. The same habit of taking rest while feeding may in some cases be noticed here as well ; thus one larva ate about two-thirds of the skin and then took a long rest of thirty-six minutes before it ate the remaining portion. It is very interesting to note the behaviour of the horns and spines in the process of moulting ; their branches remain folded on them and those forming the rosette at the top remain closed ; the horns are short and lie on the sides of the head

as flabby pieces of skin and the spines on the body lie similarly with their ends pointing posteriorly. As soon as the head moult is cast and the skin is slipped off and even before the latter is freed from the hind end the horns and the spines begin to stand up and their branches to open. When they lie as flabby pieces of skin they are yellow in colour and it is distinctly perceptible that a green fluid is injected into them from the body and that it is the tension produced by this fluid which causes the spines to stand up and become rounded and stretched and the branches and rosettes to open out. The gradual spread of the green fluid is clearly observable. Within about six minutes from the time of actual moulting the spines and horns assume their normal appearance. When the larva hatches from the egg it does not possess either the horns on the head or the spines on the body; they appear after the first moult and grow and become more branched with the growth of the caterpillar. The colour of the young larva is pale-yellow, but it soon acquires a tinge of green which deepens later on. The full-grown larva is green in colour, possesses big branching horns on the head and branching spines on the segments of the body and a prominent broad yellow mid-dorsal stripe.

The following is a description of the instars:—

First instar.—The larva when hatched from the egg measures about $1\frac{1}{2}$ mm. and grows to about 3 mm. before it is ready to undergo the first moult. It is cylindrical in shape and pale-yellow in colour which changes to green when food is taken. The metathorax and the first and seventh abdominal segments are brown on the back. There is no sign of horns on the head or of spines on the segments of the body which are so characteristic of the grown-up larva. The head is yellow and covered with black hairs and has got a black spot above the clypeus on each side. The body is also covered with longish hairs which are black in the dorsal region and white in the lateral parts. There are five pairs of equally developed prolegs.

Second instar.—The larva is about 5 mm. long and cylindrical in shape. It develops horns on the head and spines on the body after the first moult. The head is flat in front and yellow with a white patch above the clypeus and a big black spot on each cheek; a horn about $\frac{1}{3}$ mm. long and of the same colour as the head appears on each lobe and is provided with spine-like hairs. The prothorax possesses no dorsal plate and has developed six small fleshy spines

and other smaller ones like small tubercles, each surmounted with black or white hairs; the arrangement of the prothoracic spines does not conform to the arrangement of the spines on the other segments of the body. The meso-thorax, meta-thorax and all the abdominal and anal segments have developed branched or unbranched spines which are arranged in rows, *viz.*, the sub-median rows running on each side of the median line, the supra-spiracular rows running above the spiracles, the infra-spiracular rows running below the spiracles and the sub-infra-spiracular rows running just above the legs. The meso-thorax and meta-thorax have no infra-spiracular spines. Of the abdominal segments the seventh has no sub-infra-spiracular and the eighth no supra-spiracular or sub-infra-spiracular spines, but each has unlike all the other segments an extra spine in the median line. The anal segment possesses only the sub-median spines.

The arrangement of the spines on each side of the body excepting the prothoracic spines and the median ones on the seventh and eighth abdominal segments is shown in the subjoined table :—

	Meso-thorax. Meta-thorax.		ABDOMINAL SEGMENTS:								Anal segment.
			1st	2nd	3rd	4th	5th	6th	7th	8th	
Sub-median ..	1	1	1	1	1	1	1	1	1	1	1
Supra-spiracular	1	1	1	1	1	1	1	1	1	0	..
Infra-spiracular..	0	0	1	1	1	1	1	1	1	1	..
Sub-infra-spiracular	1	1	1	1	1	1	1	1	0	0	..

The sub-median spines on meso-thorax and meta-thorax have their branches arranged at the top in the form of a rosette, as shown in figures 5, 6 & 7 of Plate II. The median spines on seventh and eighth abdominal segments and all the sub-median spines excepting those on meso-thorax and meta-thorax and the first abdominal segment are big and branching to a less extent and have no rosette at the top; the branches on all these spines are surmounted by a black-pointed needle-like hair. The sub-median spines on the first abdominal segment and all the supra-spiracular and infra-spiracular spines are smaller than the other sub-median spines and are not as markedly branching, having small protuberances like tubercles surmounted with hairs. The sub-infra-spiracular spines are very small like small fleshy tubercles surmounted with a white hair. The colour of the larva is yellowish green, the meta-thorax and the third and seventh abdominal segments being brown in the dorsal area with the sub-median and median spines on them of the same colour; there is a narrow brown stripe running on each side below the sub-median spines from the meta-thorax to the seventh

abdominal segment. There is a narrow deeper green median stripe noticeable between meta-thorax and seventh abdominal segment, this showing the course of the dorsal vessel.

Third instar.—After the second moult the larva is about 6 mm. long and grows to about 8 mm. before it is ready for the third moult. In shape it is the same as in the previous instar. The head is now shiny black with a white patch above the clypeus; the horns are about 1 mm. long and brownish yellow in colour and have become branching, having branches on the stem and a rosetted top. Besides the horns there are some black hairs and needle-like black spines on the head. All the spines are now bigger than in the previous stage; the sub-median spines have all a rosetted top; the supra-spiracular and infra-spiracular spines are now distinctly branching, the supra-spiracular spines showing a somewhat rosetted top and the sub-infra-spiracular spines have grown into long fleshy spines without any branches, but there are hairs on them. The spines on prothorax have grown bigger, one being branching and those on the first abdominal segment are also bigger and branching. The branches of the spines do not possess at the top, the black needle-like hairs noticed in the previous stage except in a few cases. The colour of the larva is green with the spines, only the brown parts and the brown spines on the meta-thorax and third and seventh abdominal segments and the stripes between them, noticed in the previous stage, are black; the median spine on seventh abdominal segment is brownish. The dorsal vessel is more distinct.

Fourth instar.—Just after the third moult the larva measures about 9 mm. and grows to about 14 mm. before it is ready for the next moult. The head is black with a big triangular white patch above the clypeus, a small greenish patch above each mandible and the posterior part behind the horns green. The horns are yellow and about 2 mm. long. Besides the horns there are white unbranched spines on the head. The sub-median, supra and infra-spiracular spines have all got rosetted tops; the sub-infra-spiracular spines are now branching. The colour is green. The black parts and spines on the back noted in the previous stage are still black, but the median spine on seventh abdominal segment is yellowish green. A broad yellow mid-dorsal stripe is very distinct between meta-thorax and seventh abdominal segment. Faint white oblique markings are perceptible in the lateral regions.

Fifth instar.—After the fourth moult the length is about 15 mm. and increases to about 30 mm. when the larva is full-grown. The head is black with the same white patch above the clypeus and other white markings above the mandibles, at the bases of the horns and also at the sides. The horns are about 5 mm. long, brownish yellow with the basal half and the branches of the rosette having a blackish tinge; besides the horns there are green un-

branched spines on the head. The colour is deep green, the venter and the lateral regions being covered with a white powder; there are faint oblique markings on the sides. The mid-dorsal stripe is broad and yellow and prominent between prothorax and the eighth abdominal segment. The spines on the prothorax are small, four only showing branches. All the other spines on the body are now with rosetted tops and are also green in colour with the exception of the sub-median spines on meta-thorax and third and seventh abdominal segments which are black. Only a faint trace is left of the black stripes in the sub-median regions.

Pupa.—When full-grown the larva usually leaves the food-plant and pupates elsewhere, for example, on the walls of houses, trunks of trees, etc. It sometimes pupates on the stem of the food-plant but hardly ever on the leaf. Many caterpillars were watched on castor growing in the Insectary compound; none of them pupated on the food-plants; the pupæ would be found on the sides of a wire gauze cage which happened to stand in the midst of the castor plants; occasionally one would be found on the trunks of trees close by or on the wall of the Insectary which was at some distance from the castor plants. The caterpillar spins a thin network of silk on the surface on which it will pupate and sits head downwards with the anal prolegs held in the fibres of the network. It rests in this position for about a day or sometimes two days in the cold weather, and then turns into a pupa by casting off the larval skin. At this time the colour of the larva loses most of the green and turns greyish. In some the green colour disappears entirely, giving rise to a dull greyish brown. The mode of shedding this skin is practically the same as noticed in the case of the Rice Leaf Caterpillar, *Melanitis ismene*.

The pupa (Plate II, fig. 8) is about 20 mm. long and about 7 mm. across the thoracic region. There are two protuberances on the anterior end and ridges on the back of thorax and anterior part of abdomen. The hind end is provided with numerous small circinate hairs which are held in the fibres of the silken network and hold the pupa hanging in air head downwards. The colour is green. A V-shaped black mark appears at about the middle of the back in the advanced stage. Before the emer-

gence of the butterfly the colour turns greyish and the wing-regions become dark grey.

Imago.—The butterfly (Plate II, figs. 9 & 10) emerges by bursting the pupa-case along the regions of the antennæ and the mid-dorsal thoracic line, the fissure on the back extending sideways and then along the margins of wing-cases to some extent. It hangs on the empty pupa-case until the wings expand and all the limbs harden properly. At this time a quantity of reddish liquid excreta is voided. The butterfly is found flying rather slowly and gracefully among castor plants or any vegetation which grows somewhat densely. It occasionally sits on a leaf slowly folding up and unfolding the wings or holding them down flat for a short time.

DANAIS CHRYSIPPUS, LINN.

THE AK BUTTERFLY.

(PLATE III. FIGS. 5—9)

[Bingham. Fauna of India. Butterflies, Vol. I, 1905, p. 11.]

Distribution.—A widespread species throughout our limits (the Indian region) and found in Southern Europe, Syria, over a great part of the Ethiopian Region, through Arabia, Persia and Afghanistan. Eastwards it extends to China and through the Malayan sub-region to Sulu and the Celebes. (Bingham).

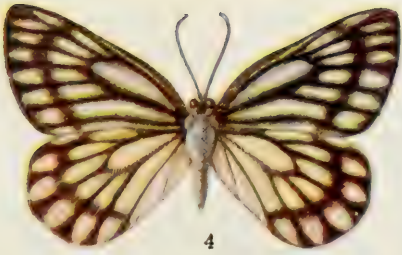
This is a common butterfly, orange-brown in colour with black and white markings, found flying gracefully any time of the day. It occurs throughout the year. The caterpillars are common on the Ak or Akanda plants, *Calotropis gigantea*, the milkweed, on the leaves of which they feed. In September 1909 they occurred in large numbers in a plot of *Asclepias semi-lunata* grown at Pusa for the Fibre Expert's experiment.

The period of the life-cycle observed in ordinary temperature is as follows:—

			(1)	(2)
Egg laid	..	..	11 a.m., 6th May.	
Egg hatched	..	..	morning, 9th "	5th July.
The larva pupated	..	..	19th "	15th "
The butterfly emerged	..	..	27th "	22nd "

The egg.—The egg is cylindrical, tapering abruptly at the top, and with the sides ribbed longitudinally. It measures about $1\frac{1}{2}$ mm. in height and a little more than 1 mm. in breadth. It is set vertically on the surface of the leaf. The colour is creamy white. The

PLATE III.



4



3



1



2



6



5



8



7



9



eggs are deposited singly on the leaves of the plant. The leaves chosen are not always tender. One egg was observed to be laid at 11 A.M. on 6th May.

The caterpillar.—The young larva hatches out of the egg by gnawing a hole at one side near the top. After emergence it eats the deserted egg-shell entirely and then proceeds to feed on tender leaves.

The young larva is cylindrical in shape and is about $2\frac{1}{4}$ mm. long. The head is black, shiny and slightly larger than prothorax. The colour of body is slightly greyish pale yellow. The prothorax bears two black spots at the sides. There is a small brown tubercle at each subdorsal region of mesothorax and of second and eighth abdominal segments. These later on develop into the long filaments characteristic of this caterpillar. The larva possesses a black anal shield and five pairs of equally developed prolegs. In the course of about a day faint yellow bands are perceptible under the lens on the back and the brown tubercles develop into small spines. Just before the first moult the larva is about 5 mm. in length and yellowish brown in colour. The spines are red. After the first moult, the larva is about 6 mm. long. The characteristic banded appearance with dark velvety brown and yellow bands of the grown-up larva is evident. The head is black and shiny and has developed one white semi-circular marking enclosing the white clypeus and a white spot above the clypeus. The black shiny spots are present on whitish prothorax. The spines or filaments on mesothorax and second and eighth abdominal segments are bigger and black. The ventral surface is deep red brown, almost dark. After the second moult the larva is about 9 mm. long. The head has developed one more semi-circular white marking on the front. The brown bands on the segments have become black. The filaments have become longer than in previous stage, the mesothoracic pair being more so than the two abdominal pairs.

After the third moult the larva is about 18 mm. long. Filaments have become still longer and the colouration noted in the previous stage is more developed.

After the fourth moult, the larva is about 25 mm. In this stage it becomes full-grown measuring about 40 mm. The mesothoracic filaments are about 8 mm. long, while those on second and eighth abdominal segments are about 5 mm. long. The bases of all the filaments are red. The legs are black and the spiracular regions yellow. The general colour is dark grey; but the caterpillar is banded in appearance with the characteristic black and yellow bands. On each segment there are five narrow black bands, the second and third enclosing a yellow band which is divided in the median region and extends up to about the sub-median parts.

The caterpillars pass through four larval moults and pupate at the fifth. The table below shows the periods of the instars of two :—

Larva hatched.		1st moult.	2nd moult.	3rd moult.	4th moult.	5th moult ; pupated.
(1)	9th May	11th May	13th May	15th May	17th May	19th May
(2)	19th "	21st "	24th "	26th "	28th "	31st "

A record was kept of the weight gained by the second larva and of the excrement passed. The excrement was not allowed to dry before weighing.

May 19: The caterpillar hatched. Weighed '04 grain and measured $2\frac{1}{2}$ mm. in length.

„ 21 First moult; length 6 mm. Weight 1 grain. Weight of excrement passed from the time of hatching up to this moult '13 grain.

„ 24 Second moult; length 8 mm. Weight '18 grain. Weight of excrement passed between first and second moults '3 grain.

„ 26 Third moult; length 12 mm. Weight '63 grain. Weight of excrement passed between second and third moults '3 grain.

„ 27 Weight 2·3 grains. Excrement passed in the last 24 hours '15 grain.

„ 28 Fourth moult; length 25 mm. Weight 3·4 grains. Excrement in the last 24 hours 1·1 grain.

„ 29 Length 33 mm. Weight 9·8 grains. Excrement in the last 24 hours 20·6 grains.

„ 30 Length 38 mm. Weight 12·1 grains. Excrement in the past 24 hours 15·7 grains.

„ 31 Pupated. Excrement up to the time of pupation 2·7 grains. Weight of pupa 9·96 grains. Weight of last larval skin '13 grain.

June 1 : Pupa 9.79 grains.

„ 2 „ 9.7 „

„ 4 „ 9.5 „

„ 5 „ 9.46 „

„ 6 The butterfly emerged; a male, which weighed 4 grains. The empty pupa-case weighed 1 grain.

Similar records of the development of caterpillars will be found in Vol. II, Nos. 5 & 6 of this series of Memoirs. More complete records about the growth of caterpillars showing food consumed, weight gained and excrement passed will be found at pp. 33-35 of Vol. IV, No. 1.

The pupa.—When the caterpillar is full-grown and ready to pupate, it forms a thin padding by applying silk on the under-surface of a leaf or somewhere on the stem. Then the hooks on the anal prolegs are well entangled and held in the fibres of the padding and the larva hangs in the same manner as the pupating caterpillar of *Melanites ismene*. (Plate I, fig. 5). In the course of the day it transforms into a pupa by casting off the larval skin. The pupa too hangs in the same way as that of *Melanites ismene*.

Excluding the cremaster the pupa measures about 18 mm. in length, about 8 mm. across at the golden ridge, about $6\frac{1}{2}$ mm. across the middle, and about $5\frac{1}{2}$ mm. near the head end. It is light green or pinkish in colour with golden spots on the head (lower) end and a black bordered golden line or ridge in the posterior part on the back encircling about half the circumference.

The butterfly.—The butterfly emerges by bursting the lower end of the pupa and hangs on the empty pupa-case. When it emerges the wings are crumpled and small and the abdomen is very thick and short. The wings quickly expand and harden and the abdomen lengthens and becomes thinner. In the course of about an hour the butterfly is able to fly.

Enemy.—The caterpillars are extensively parasitised by a Tachinid fly. The caterpillar pupates with the parasitic maggot or maggots in its body. When the maggots are full-grown they come out and drop on the ground and pupate there. Out of 227 caterpillars and pupæ collected, 134 or about 59% were found parasitised.

PIERIS BRASSICÆ, LINN.

THE CABBAGE WHITE.

(PLATE IV).

[Bingham, Fauna of India, Butterflies, Vol. II, 1907, p. 170.]

Distribution.—Europe, Northern and Central Asia, the Himalayas from Chitral to Bhutan up to 10,000 feet (Bingham). Major H. C. Tytler records it from the Naga Hills (Jl. Bomb. Nat. Hist. Soc., Vol. XXI, p. 591). He remarks:—"Rather scarce; two males and three females taken at Kohima in February, August and October." It descends about 100 miles of the Himalayas in the plains.

Broods.—The Cabbage White Butterfly, *Pieris brassicæ*, occurs within about 100 miles of the Himalayas in Eastern and North Bengal, Bihar, the United Provinces and the Punjab. Recently (1912) it has been reported to occur on cabbage seedlings far down in Lower Bengal at Midnapur and this too in November; no specimens were sent and the report has to be accepted with caution. It appears at Pusa late in January or early in February. Thus in 1911 it was for the first time found flying over cabbage and cauliflower in the Insectary compound on the 6th February and eggs were found the same afternoon. In 1912 it was observed for the first time on 13th February. Three or four generations occur consecutively, mainly on cabbage and cauliflower and then the insect disappears by May or even earlier and reappears towards the close of the next cold weather. It is believed that the butterflies migrate from the hills, but there is no actual proof of such migration. However it is certain that they stop breeding in the plains in the hot weather. In 1912 and 1913 large numbers of caterpillars were reared in order to see if any of them would æstivate in the pupal



THE CABBAGE WHITE BUTTERFLY.

stage, the caterpillars being collected as long as they were found in the fields. All became butterflies, which were given opportunities for laying eggs and breeding but they died without laying any eggs, although the conditions were practically the same in which they bred in confinement earlier in the season.

Food-plants and damage.—In the neighbourhood of Pusa these butterfly caterpillars cause serious damage to cabbage, cauliflower, lettuce and similar plants. There is a reference to *Pieris brassica* under the name of *Mancipium nepalensis*, Grey, in the Indian Museum Notes, Vol. II, pp. 45-46, where a report is mentioned as made from Umballa in January 1890, stating that caterpillars of this butterfly attacked gram, *toria* (Rye), linseed, sugarcane and garden vegetables, such as radishes. An attempt was made to feed the caterpillars with all these plants, but they would not even touch gram, linseed and sugarcane and died. All cruciferous plants they ate without distinction. It would seem, therefore, that the statements in the Indian Museum Notes are based on mistaken observations. At Pusa the caterpillars were for the first time found on Cape Gooseberry to which they had strayed, probably for pupating and which they never ate.

Life-history.—The period of the life-cycle in warm weather is about four weeks from egg to butterfly and about two days more to eggs again. If the weather be cold this period is longer. The period in warm temperature is shown below:—

Egg laid.	Egg hatched.	Larva pupated.	Butterfly emerged.	Periods in days.
31st March	4th April	21st April	28th April	4 = 17 7 = 28
1st April	5th ..	20th ..	29th ..	4 = 15 9 = 28
4th ..	8th ..	24th ..	3rd May	4 = 16 9 = 24
13th ..	17th ..	3rd May	10th ..	4 = 16 7 = 27

The egg.—The butterflies being diurnal in habit, eggs are laid only during the day. The eggs are deposited in clusters and on

cabbage and cauliflower, usually on the undersurfaces of leaves near the apex. The clusters are very prominent, being big yellow patches on green leaves, but they are hardly visible to a man walking among the plants and the leaves have to be turned up before they come into view. It was not actually determined how many eggs each butterfly is capable of laying. In the Insectary the maximum number of eggs laid in the same cluster was 74; but from the fields, clusters containing up to 203 eggs have been collected. Therefore it can be taken that each butterfly is capable of laying not less than 200 eggs and probably lays many more. Each egg is flask-shaped and measures a little more than 1 mm. in height and about $\frac{1}{2}$ mm. across the thickest part and tapers upwards; the sides are ribbed in regular order longitudinally; the colour is orange yellow, but it becomes dim about a day before hatching and just before hatching it turns rather grey and there is a faint black spot near the top marking the head of the embryo within the shell. The eggs stand vertically on the surface of the leaf and are neatly arranged in the cluster, but so that they do not quite touch one another. The period of the egg-stage is, as shown in the table of the life-cycle, about four days when it is warm. It is longer in a cold temperature; thus eggs laid on 27th February 1912, hatched on 3rd March, after five days and some eggs laid on 8th February 1911, hatched on the 17th February, after nine days.

The larva.—When ready to hatch out from the egg the fully developed embryo or the young larva gnaws a big hole from within at the upper part of the shell and emerges through it. The empty egg-shell is white. The eggs in the same cluster hatch almost at the same time. This is natural, as they are deposited almost at the same time. After emergence the young caterpillars eat the empty egg-shells as their first meal, consuming them wholly and also nibbling a portion of the surface where they stand. Not infrequently that portion of the leaf is bitten through, a big hole being produced in its place. The young larva is about 2 mm. long and cylindrical in shape. The head is big, black and shiny and the segments of the body are indistinct. The colour is uniform pale-

yellow. All over the body there are small white hairs. The larva possesses the usual three pairs of thoracic legs and five pairs of prolegs. The body of the just-hatched larva is pale-yellow. In the course of a day it becomes slightly greenish and covered with many black points which are actually small tubercles surmounted with hairs and take some time to turn black. The prothoracic shield also takes some time to turn black. It is divided at the middle. The head develops a white space in front, of the shape of an inverted V which becomes yellowish later on and more prominent at successive moults. After the first moult the larva almost exactly resembles the full-grown caterpillar in colour and appearance, the colour being yellowish-green. The full-grown larva is cylindrical and is about 40 mm. long, the average daily growth of the larva being about $2\frac{1}{2}$ mm. The posterior two-thirds of each lobe of the head is greenish-grey and has got a large black spot laterally appearing like a big black eye. The front is black and encloses a pale-yellow triangular mark with its apex turned upwards. The head is covered with small hairs. The body is yellowish-green and is covered with small as well as long white hairs. There is a green narrow median line and a big dark patch consisting of numerous small dark spots, above the spiracle of each segment. This region shows a network of black markings upon a yellowish-green background. From a little above the spiracles downwards, the colour is not so green. This region is also covered with hairs arising from very small numerous black or dark-brown tubercles. The larva passes through four or five moults. Out of four larvæ noticed, two moulted four times and two five times. Before each moult the larva rests for some time: the segments of the body become very marked and the head becomes a little detached from the prothorax which seems to be prolonged into a sort of neck. The skin bursts in the thoracic region along the mid-dorsal line and the larva walks out as from a case. In all the moults except the last one at which pupation takes place, the moults of the head and the skin are cast separately. The cast skins are never eaten and the larvæ being of a gregarious habit, many skins will be found at the same place.

The periods of the instars and the number of moults are shown below :—

Hatched.	1st moult.	2nd moult.	3rd moult.	4th moult.	5th moult.	Butterfly emerged.
1. 20th Mar.	25th Mar.	29th Mar.	1st April	5th April (pupated.)		15th April
2. ..	..	28th ..	31st Mar.	4th April (pupated.)		"
3. ..	..	..	30th ..	1st April.	5th April (pupated)	14th ..
4. 5th April.	9th April.	12th April.	15th April.	20th April.	23rd April (pupated)	1st May

The pupa.—Throughout the larval life the caterpillars are gregarious in habit, living, moving and feeding in company. Many will be found collected together and feeding side by side. As long as food is available they hardly show any inclination to disperse; consequently, those which hatch on the same plant continue to remain on it until forced to leave it by scarcity of food. When, however, they are full-fed and full-grown they part company and scatter in different directions. Not a single caterpillar or pupa will be found where a few days ago literally hundreds might have been feeding. They sometimes travel over great distances in search of proper places where they can safely pass the pupal stage, high and shady places being generally preferred. In the Insectary compound they have been observed to travel a distance of about fifty feet from the food-plants and then to climb upon a big tree and pupate on the undersurfaces of leaves and to crawl up the Insectary wall and pupate under the cornice. It is evident that pupæ can hardly be found in pairs or several together.

The caterpillar exudes a white silk from the spinneret and applies it on the surface where it means to pupate in the form of a netting. It then entangles the hooks on the anal prolegs in the fibres of this netting and passes a silken girdle over the first abdominal segment fixing the two ends of this girdle at two points in the netting. More silk is found to be accumulated at these three points of attachment than at other places in the netting. The head of

the pupating larva and of the subsequent pupa is turned upwards. Having thus secured itself in position the larva rests for about a day, becoming much shortened in length. It then turns into a pupa by casting off the larval skin.

The pupa measures about 22 to 24 mm. in length and 5 mm. across the wing region. There is a small snout at the head end and the hind end is tapering from the third abdominal segment. In the mid-dorsal region there is a longitudinal ridge on the three thoracic segments; the ridge disappears on the first and second abdominal segments and reappears at the posterior part of the third abdominal segment and runs up to the anal segment; it rises high like a pyramid on the meso-thorax. At the spiracular region on each side on the second, third and fourth abdominal segments there is a ridge which protrudes into a spine on the third abdominal segment. The girdle passes over the first abdominal segment. When newly formed the pupa is pale yellow; then it changes to green and finally to grey; it is speckled with black all over the surface. The snout is yellow and the mid-dorsal ridge too is spotted yellow.

The imago.—The head end of the pupa bursts along the regions of the antennæ and the mid-dorsal line of the thorax. The butterfly struggles through this opening with soft crumpled wings and hangs from the empty pupa-case until the wings expand and all the appendages harden. At this time it voids a quantity of liquid excrement which is pinkish or reddish in colour. Sometimes the liquid excrement is voided inside the pupa-case just before the butterfly emerges; in such cases the hind part of the pupa looks deep pink. Sometimes again it is voided similarly when the butterfly has come out partly from the pupa-case. The butterfly measures $2\frac{1}{2}$ inches across the wings. The males and females are of about the same size but the abdomen of the female is slightly thicker. The body is black or dark grey. The upper surfaces of the wings are white except the outer corners of the forewings which are black; in addition to these black corners the female has two black patches in the middle of the forewings and she can be at once distinguished by them. On

the underside the colouring of both the wings is the same in both sexes; the forewings are white with two black patches in the middle, the portions of the corners corresponding to the black above being yellow; the hind wings are yellow. The butterflies are diurnal in habit and literally swarms of them will be found flying sportively over cabbage and cauliflower plants. When they sit the wings are held folded above the back. They too indulge in the same kind of courtship as has been noticed in the case of the Tur Hair Streak (*Catochrysops cnejus*). They couple end to end and may mate on the day of emergence. In copulation the male is rather passive and seems to hang down inertly. Mating was observed to last for $1\frac{1}{2}$ to 2 hours. At night the butterflies are inactive and hang on some place motionless; in the cage they hardly stirred even when light was introduced and they were actually touched. In confinement they do not live long; they lived for not more than four or five days in the Insectary.

Enemies.—The caterpillars are parasitised by a Dipterous (Tachinid) and a Hymenopterous parasite. But they increase so rapidly that these parasites have hardly any effect as an appreciable check.

Preventive and remedial measures.—It is not easy to prevent the butterflies from laying eggs. The simplest remedy is to examine the plants at intervals of about three days and destroy the egg-clusters which can be easily done by rubbing them with finger. If any egg-cluster escapes notice, the young larvæ cannot fail to attract attention on the nibbled leaf which is to be removed and buried with the caterpillars. On account of the gregarious nature of the caterpillars large numbers of them can be disposed of without any appreciable damage to the plants. The examination of the plants too, is a simple work capable of being carried out easily by a boy and does not involve much time. This remedy is particularly feasible in the case of garden crops, such as cabbage, cauliflower, etc.

DELIAS EUCHARIS, DR.

(PLATE III, Figs. 1-4).

[Bingham, Fauna of India, Butterflies, Vol. II, 1907, p. 141.]

Distribution.—The Himalayas up to 7,000 feet; the whole of Continental India except the desert tracts; Ceylon.

This is one of the commonest butterflies of the plains. The caterpillars feed on the misletoe (*Loranthus*) growing on various trees, such as mango, sissoo (*Dalbergia sissoo*), gular (*Ficus glomerata*), etc., and are very largely found specially about March when warm weather sets in after winter. The butterflies are notably flower-frequenting in habit and have been observed at Pusa and at Rangpur to visit mustard flowers in large numbers in November and December.

The life-cycle was observed in winter and again in March and April, the following being the periods of the stages:—

Eggs, apparently freshly laid, collected, 8th March.	29th Nov.
Eggs hatched, 11th-12th March.	4th Dec.
The caterpillars pupated, 1st April.	21st Jany.
The butterflies emerged, 10th April.	11th Feby.

The egg.—The eggs are deposited usually on the upper-surfaces of tender leaves of the misletoe, one to several eggs being laid on the same leaf. Up to sixty-nine eggs have been found in a cluster on a single leaf. Even when thus deposited in a cluster unlike most butterfly eggs, they are scattered irregularly. They stand vertically on the surface on one end which is broad, or lie on one side. The egg is about $1\frac{1}{2}$ mm. high and about 1 mm. in diameter at the base. It is round, flask-shaped, being narrow at the top which, however, does not end in a point but is concave.

There are longitudinal ribs on the surface. The upper ends of the ribs run beyond and project to some extent beyond the rim of the concavity. The colour is yellow.

The larva.—The young larva hatches out of the egg through a hole gnawed near the top. It then eats the white empty shell either partly or wholly and then begins to feed on the leaves. Throughout the larval period it throws out silk profusely. The caterpillars are gregarious in habit, several being found sitting side by side on a leaf and eating it from the edge inwards. The young larva is about 2 mm. long and cylindrical in shape. The head is black, shiny and the body yellow. There are yellowish hairs scattered on the segments and the usual five pairs of prolegs are present, all being equally developed. In appearance and shape the larva hardly undergoes any change but develops a brown or rather copperish brown colour as it grows. When full-grown, it measures about 32 mm. in length and about 5 mm. across. The head is dull black. There is a narrow black thoracic shield. The body is uniform copperish brown and the anal segment black. There are long white hairs scattered on the segments. The bases of a row of hairs in the sub-median region and of another row in the sub-spiracular region are white tubercles and these make the larva look somewhat white-spotted.

The pupa.—The caterpillars pupate as usual by attaching the hind end to a previously prepared silken padding. Besides, there is the usual girdle passing over the posterior part of the first and sides of the second abdominal segment. The head of the pupating larva and of the subsequent pupa is turned upwards. The pupa is similar in shape and appearance to the pupa of the Cabbage White butterfly, *Pieris brassicæ*. It is, however, yellow in colour and bears a series of black tubercular processes. The butterflies emerge from the pupa in the same way as *Pieris brassicæ*.

PLATE V.



CATOPSILIA PYRANTHE, LINN.

(PLATE V, Figs. 7-11).

[Swinhoe, *Lepidoptera Indica*, Vol. VII, 1905-10, p. 90.]

Distribution.—Throughout India ; Assam, Burma, Tenasserim, not ascending the Himalayas to above 7,000 feet. It extends to China on the east and as far as Australia southwards (Bingham). Ceylon, Siam, Annam, Malay Peninsula, Sumatra, Java, Borneo, Formosa, Hainan (Swinhoe).

This is a common butterfly the larvæ of which feed probably on all species of *Cassia*. They have been reared on *Cassia occidentalis*, *C. fistula*, *C. sophera*, *C. sophera* var. *purpurea* and *C. tora*. The caterpillars are extremely common on these weeds specially in the rains. They have also been collected in April. It is not known in what state they pass the winter. Cycles were observed in June and September and the periods of the stages were as follows :—

—	1	2
Eggs laid ...	25th September	9-15 to 9-24 A.M., 7th June.
Eggs hatched ...	27th September	5-7 A.M., 9th June.
The caterpillars pupated ...	6th October	20th June.
The butterflies emerged ...	13th to 14th October	27th June.

The egg.—The butterflies can be observed flying over the plants and depositing eggs in the morning or any time of the day. One morning in June a butterfly was observed laying eggs on a *Cassia fistula* tree about eight feet high. A brood of caterpillars had been feeding on it and it had been stripped of about half of the old leaves. Many new shoots had grown on most of which the leaves did not yet open. The butterfly flew over and round the tree occasionally sitting on a leaf or on leaf-stalk and depositing one egg every time.

The abdomen was curved down so that the hind end touched the surface and when it was raised after about two or three seconds, the white egg was there ; at the same time the butterfly took to wing. In this way twenty-four eggs were deposited in the course of nine minutes from 9-15 to 9-24 A.M., and then the butterfly flew away. Of these twenty-four eggs, two were deposited on the stem of tender shoots, one on the stalk of a tender leaf, one on the undersurface of an old leaf, and the remainder on tender leaves.

The eggs are deposited singly on either surfaces of leaves or their edges and occasionally on leaf-stalks and tender twigs. The egg stands vertically on the surface. It measures about $1\frac{1}{2}$ mm. in length and about $\frac{1}{2}$ mm. in diameter at the middle. It is tubular or cigar-shaped with tapering ends. The entire surface is ribbed longitudinally. The colour is white and hardly undergoes any change before hatching.

The larva.—The young caterpillar hatches out of the egg through a hole gnawed on one side. After emerging it turns round and eats the empty shell either entirely or only one side of it and then strays about and begins feeding on the leaves, nibbling small holes in their surface.

The newly-hatched caterpillar is about 2 mm. long and cylindrical in shape. The head is bigger in diameter than the body which tapers very slightly towards the hind end. The segments are not very distinct and bear longish hairs. The colour is uniform white, but it soon changes to pale yellow and acquires a greenish tinge as soon as green food is taken. There are the usual five pairs of prolegs and under a high power lens the rudiments of the transverse folds on the segments so characteristic of the grown-up larva, are observable. The larva passes through four larval moults and pupates at the fifth. The periods of the instars of two caterpillars which hatched on the same day are given below :—

Hatched, morning,	27th September.
First moult, afternoon,	28th "
Second " "	30th "
Third " "	1st October.
Fourth " "	3rd "
Fifth " pupated,	6th "

When the larva was resting before casting off the first moult, small drops of a clear liquid were found collected at the tips of the hairs. After the first moult it grows to 5 mm. in length. The head is yellow and the body green. All over the head and body minute tubercles appear surmounted with minute back hairs.

After the second moult the length is about 7 mm. and there is no distinct change.

After the third moult the larva is 13 mm. long. The head is greenish-yellow and body green. The segments are not at all distinct, but the whole of the back is a series of narrow transverse folds. As already noted these folds are apparent in earlier stages and have now become quite distinct. The small black tubercles are arranged on the folds. A white stripe appears in the lateral regions.

After the fourth moult the larva is about 23 mm. long. A black edging appears on the upper margin of the lateral white stripe. Really this edging is formed by black tubercles which are also bigger than those on the back.

When full-grown, the larva is about 40 mm. long and about 5 mm. broad. The shape is about cylindrical being slightly compressed dorso-ventrally. The colour and appearance are as have been described above. Between the white stripe and its black edging on the upper margin a narrow yellow line is apparent.

The pupa.—When full-grown and about to pupate most of the caterpillars leave the food-plants and pupate elsewhere. The larva spins out silk and applies it to leaf or stem where it means to pupate. The anal prolegs are held in the fibres of this padding and a girdle of silk is passed over the back at the meta-thoracic region, the two ends of the girdle being fixed to a point on the padding. The larva then rests in a ventrally curved posture in the same manner as the lemon butterfly (*Papilio*) caterpillar, Pl. VI, fig. 7, and transforms into a pupa by casting off the larval skin. The head end of the pupa is usually turned upwards; it may, however, be at the same level as the hind end or even point downwards.

The pupa is about 24 mm. long and compressed laterally in the wing region. The hind part is tapering and the head end rather abruptly tapers into a small pointed snout. The colour is green like the leaf of the food-plant. There is a small ridge on each side running from the snout to the hind end and also one in the mid-dorsal region on prothorax. These ridges are yellow and the lateral ones look like stripes. The pupa is fastened to the silken padding by hooks at the hind end and is held in position by the girdle.

Before emergence of the butterfly the pupa turns yellowish chalky white and the parts of the butterfly are visible. When the butterfly emerges the head of the pupa breaks away, the fissure running along the antennæ; at the same time the thoracic ridge opens and this opening runs up to the meta-thorax and then extends on each side between meta-thorax and the first abdominal segment. The two halves of the pronotum also break, but do not fall off entirely. After emergence the butterfly hangs on the empty pupa-case until the wings expand and all the limbs harden. At this time it usually voids a quantity of liquid excrement which on drying turns into a chalky white powder.



LEMON CATERPILLARS.

PLATE VII.



THE LEMON CATERPILLARS.

THE LEMON CATERPILLARS.

(PLATES VI & VII.)

Papilio demoleus, Linn.

[Bingham, Fauna of India, Butt. Vol. II, 1907, p. 39.]

AND

Papilio pammon, Linn.

[Bingham, *P. polytes*, Fauna of India, Butt. Vol. II, 1907, p. 61.]

Distribution—*P. demoleus*.—Kashmir to Ceylon; Assam to Upper Burma, up to a moderate elevation; extending to Persia and eastwards to China and Formosa. A local form *malayanus* distinguishable by the width of the median cream coloured band on the hindwing, which Bingham considers as a race, occurs in Lower Burma, Tenasserim and Malay Peninsula. Many specimens from Assam to Lower Burma are intermediate as regards the width of this band (Bingham).

P. pammon is a polymorphic form. The female varies slightly but is fairly constant throughout its range; (Bingham notes two aberrations of the male from Southern India): the female generally with two forms, in Southern India and Ceylon with three, strikingly different in appearance.

It occurs almost throughout our limits, including the Andamans and Nicobars; extending to Siam and the Malayan sub-region to Sumatra (Bingham).

Relation between the two.—These two butterflies live in close relationship in all their stages, partaking of the same food. In their younger stages they are liable to be confused, as the distinguishing characteristics are not very marked. Eggs of both are laid promiscuously on the same plant; also the larvæ live and

feed side by side. Butterflies also will be found fluttering about in company over the food-plants. The relation between these two butterflies seems to be more intimate than is supposed when two insects of the same genus live on the same food-plant. One morning at about 7-30 A.M. while watching some of these butterflies among lemon and orange trees in the vegetable garden at Pusa, the following observation was made. They were all in a state of continual flutter, paying visits to plant after plant and branch after branch of the same plant as if reconnoitring the whole of it, sometimes getting into the dense part of the foliage and again coming out and flying round the plant. Occasionally one would sit on a tender twig, but only for a moment and again took to wing.

One *P. pammon*, a female, was noticed sitting on a branch of a lemon tree with her wings more or less extended. After a few moments a male *pammon* came across her, approached her, and fluttered round advancing the hind end of his body towards that of the female trying to copulate. The female seemed to be quite passive and dropped on to and caught hold of a twig, a few inches below. The male flew away.

After a few moments a *demoleus* male came and made vigorous overtures, which the female *pammon* not only did not reject, but, on the other hand, seemed to like. She approached the hind end to that of the advanced abdomen of the *demoleus* male; the hind ends met several times but actual copulation did not take place. The female seemed to be in a very nervous state; she then dropped down to a branch below and after a few seconds to the ground and continued to sit for about six minutes on a dry twig on which she happened to alight. The male flew away. Then she flew to a lower branch of the same tree where she remained sitting until after about seven minutes another *pammon* came flying to her, she took to wing and both began to flutter about in company for about 15 or 20 seconds; then the female came and sat with the wings extended on a branch of a neighbouring plum tree and continued to do so for about fifteen minutes when the observations were

discontinued. She was the only one to behave in this manner, all others were continually fluttering about. Evidently she had newly emerged and had not yet mated. From this it appeared that it may not be impossible that *P. pammon* and *P. demoleus* may mate, although they have not been actually observed to do so.

Proportion in which P. demoleus and P. pammon occur.

Of the two butterflies, *P. demoleus* is very common, the other occurring in small number. Between 4th and 22nd April, sixty-five caterpillars were collected on orange trees and of them only two were *P. pammon*, the rest being *P. demoleus*. Again about the same time, between 4th and 25th April, 245 eggs were collected from the same trees. Out of them, 138 *P. demoleus* hatched, while only eleven were *P. pammon* and the rest were parasitised. Out of seventy-nine caterpillars picked from two young lemon trees on 25th May, all proved to be *P. demoleus*.

Distinguishing characters in the earlier stages of P. demoleus and P. pammon.

Eggs.—The egg of *P. pammon* is slightly bigger than that of *P. demoleus*. Four *P. demoleus* eggs measured 1.15, 1.09, 1.06 and 1.01 mm. in diameter. Two *P. pammon* eggs measured 1.25 and 1.2 mm. in diameter.

Larvæ, first instar (Plate VII, figs. 1 & 6).—The newly hatched caterpillars are very easily distinguishable. *P. pammon* is slightly bigger and less hairy and less spiny in appearance than *P. demoleus* which has comparatively big spines all over the body, *P. pammon* having rather tubercles surmounted with hairs in place of spines on all segments except prothorax, seventh and eighth abdominal and first anal segments. *P. pammon* is yellow with brownish sides while *P. demoleus* is dark brown with a whitish spot in the middle of the body, this spot in *P. pammon* being much fainter.

Second-fourth instars (Plate VII, figs. 2, 3 & 7, 8).—*P. demoleus* retains the spines while the spines in *P. pammon* either disappear or are reduced to small tubercles except those on pro-

thorax and eighth abdominal and first anal segments, so that this latter has a more or less smooth appearance. The colour in both is dark brown; *P. demoleus* may be almost black; *P. pammon* has a greenish tinge. The V-shaped white marking in the middle of the body is present in both. Compared with *P. demoleus* the meta-thoracic region of *P. pammon* is much thicker.

Fifth or last instar (Plate VII, figs. 4 & 9).—The two larvæ resemble each other more than in previous instars; both are green and spineless. In rare cases *P. demoleus* may have spines as noted later on in the first variety of the larva (p. 47) of this butterfly. The prothoracic spines or horns are reduced in both, but are bigger in *P. demoleus* than in *P. pammon*. The principal distinguishing features are the markings on the composite segment formed by the union of meta-thorax and first abdominal segment. In *P. pammon* (Plate VII, fig. 9) the region above the legs on the thoracic segments is a velvety dark grey; this grey colour goes up along the posterior edge of the composite segment and meets on the back and is followed by black on the anterior part of the second abdominal segment. The anterior edge of the composite segment has a yellowish or brownish collar which extends on each side up to about the supra-spiracular region (where its extremity is ocellated) and does not go down further to meet the dark grey above the region of the legs; the extremities are turned a little posteriorly off from the inter-segmental region between meso-thorax and meta-thorax; there is no black band preceding this collar. In *P. demoleus* (Plate VII, fig. 4) there is not such a broad dark grey space above the region of the legs on the thoracic segments. The two edges of the composite segment, viz., the anterior and the posterior are respectively preceded and followed by broad black bands which go down straight to the lateral regions, the marking on the anterior edge being thus quite different from that in *P. pammon*.

Pupæ (Plate VII, figs. 5 & 10).—The protuberances (about 2 mm. in length) on the head of the pupa of *P. pammon* are

bigger and therefore the indentation deeper than in *P. demoleus* in which the protuberances (about $\frac{1}{2}$ mm.) are never big and the indentation not deep. *P. pammon* pupa has a much broader appearance about the third abdominal segment, the broadest part in both pupæ. Also it may be noted that no brown *P. pammon* pupa has been noticed.

Food-plants and damage.—Both *P. demoleus* and *P. pammon* are destructive to young Citrus trees as they defoliate them. They eat young leaves of grown-up trees, but the damage thus caused hardly ever proves very injurious to them. *P. demoleus* has been found on Bael (*Egle Marmelos*) and *Psoralea corylifolia* and probably feeds on other *Rutaceæ*. *P. pammon* too will most probably be found on all these plants.

Broods.—*Papilio demoleus* occurs in the plains throughout the year and as there is no regular succession of broods all the stages may be found at any time. Most probably this too is the case with *P. pammon*. As will appear from the tables, the periods of the life-cycle are enormously lengthened in the cold weather. It is probable that in cold places, *e.g.*, the hill stations, there is a period of hibernation which is passed in the pupa state. A pupating larva collected in Shillong (5,500 ft.) on 21st October, pupated on 22nd October and the pupa lived through the whole of the winter. It, however, did not emerge and was found dead on 13th April.

Life-history.—The life-histories of *P. demoleus* and *P. pammon* are similar, and in a way may be considered to have been mixed up. The egg of both is round, only that part coming in contact with the substratum being flat. The egg-shell is tough and membranous and smooth. The colour is pale-yellow, becoming brownish later on with a darker brown spot at the top and ultimately turning grey before hatching. The eggs of both are laid together promiscuously, singly on leaves or leafstalks of tender shoots but mostly on leaves, either at their apices or margins or anywhere on either surface, the majority being on the under-

surface ; thus out of 30 eggs collected at random, only four were on the upper-surfaces and the rest on the undersurfaces of tender leaves. From one to ten or twelve eggs may be found on the same shoot, each leaf having from one to three or four eggs according to its size.

The young larva gnaws a hole in the shell and comes out through it and eats the empty shell. It then begins to eat young leaves biting them from the edges and feeds on leaves throughout the larval state. In the first stage the larvæ of the two butterflies are different in appearance. In the second instar their appearance begins to get similar and gets more and more so in successive instars. In the earlier stages the larvæ live on the upper-surfaces of leaves and while they rest there, present a remarkable similarity to droppings of birds. In the last instar both become green and as they grow quickly and to a large size in this instar, they leave the leaves and usually sit on stems, where they are not easily distinguishable on account of the similarity of the colour of the body to that of the stem. Again most have broad markings on the body, grey or brown in colour and mixed with white ; besides, the meta-thorax and the first abdominal segment unite in both to form a big bulging segment which has broad brown or dark grey edgings at the anterior and posterior parts ; the anterior edging has ocellated markings. The larva is in the habit of sitting with the head and the first two thoracic segments drawn in. This part is highly tapering as will appear from figures 4 & 9, Pl. VII. In the resting attitude the larva presents an appearance much like that of a snake, the anterior part from the bulging composite segment forming the head. This is more apparent in *P. pammon* than in the other.

The larvæ of both throw out a red Y-shaped soft process (fig. 3, Pl. VI) from behind the head when disturbed, at the same time emitting a strong smell which savours to a certain extent of the smell of *Artabotry odoratissimus* flowers (Kantali-champa, Bengali). The tips of the arms of the process are also vibrated. If the back

is touched the head is raised and bent over the back in the attempt to remove the cause of the disturbance with the process.

The larvæ of both pass through four larval moults and pupate at the fifth. Some, however, may have only four moults in all. Before moulting the larva spins out and applies a very thin layer of silk in the form of a netting on the surface of the leaf and sits and rests on it with the hooks on the prolegs held in the fibres of the netting. The whole period of the rest extending over several hours, seems to be passed in the attempt to extricate the new head. The skin is detached behind the head, first of all in the dorsal region, thus exposing partly the head and the anterior part of the prothorax and then gradually in the ventral region. It is then shed by a sort of a peristaltic movement of the muscles of the body, as the larva gradually moves forward. The shedding is facilitated by the backward pull exerted on the skin owing to the entanglement of the hooks on the prolegs in the silken netting. The skin retains the general shape partly as the larva moves out of it as from a case. While the larva moves forward the old head-moult is still on the head sticking over the mouthparts and is got rid of by being rubbed on the surface of the leaf. The larva sits quietly for some time, usually with the head and thorax slightly raised up in air and then turns round and eats the skin. During the period of the rest before moulting and specially just before casting off the skin, the larva is quite helpless but is held in position by the fastening previously secured of the prolegs to the silken netting.

Pupation takes place on the plant, generally on the stem and occasionally on the leaf. When full-grown many caterpillars leave the food-plant and pupate elsewhere and may walk long distances before doing so. Hence very few pupæ are actually found on the plant which nourishes a large number of caterpillars. The larva prepares a silken padding. The anal prolegs are held tightly in the fibres and a silken girdle is passed over the meta-thoracic region, the ends of the girdle being fixed to two points in the padding. In order to make these three points of attachment secure, more silk

is found to be applied at these places. When pupating on a twig silk is applied all round it, and at the anal point of attachment specially, a thick ring of silk is formed. Thus securing itself the larva rests as shown in fig. 7, Plate VI, with the head bent towards the ventral surface. At this time the body is much contracted. Before the actual rest commences the larva voids a large quantity of soft excreta. The head of the pupating larva and necessarily that of the pupa is always turned upwards. Ordinarily after about a day of rest the last larval skin is cast and the pupa appears.

The pupæ of *P. demoleus* are of three different colours : (1) green, (2) yellowish-brown or dry straw, (3) dark grey with black markings looking like a roughly notched rotten piece of dry wood. The pupæ of *P. pammon* are : (1) green, or (2) bluish-green with grey, wood-brown and black patches all over. The different colours are not indicative of sex in either species.

Emergence of the butterfly.—The colour of the green pupæ remains green till several hours before emergence of the imago (pupæ are green in evening but are found changed the next morning and the butterflies emerge within an hour or so) when it turns paler and then brown. Before emergence of the imago all its parts and the stripes and spots on the body and wings are clearly visible. In the brown and dark grey pupæ the changes are not so visible. The empty pupa-case of the green pupæ is dirty white and thinner than that of brown and dark grey pupæ in which the pupa-cases are brown and dark grey respectively.

The pupa-case first of all bursts transversely at the inter-segmental suture between head and prothorax on the dorsal surface. The head is thus freed and the butterfly emerges by further efforts with movements of legs and body. These efforts burst the mesothorax in the mid-dorsal region and extend the fissure behind the head along the antennæ on each side up to about the end of the wing region. The butterfly is free from the pupa-case within less than half a minute. While it struggles to extricate itself it

voids a quantity of dirty brown liquid excrement inside the pupa-case. After coming out it sits quietly hanging on the empty pupa-case. Unless the wings hang downwards they cannot expand properly. The following is the record of observation on the emergence of a *P. demoleus* female butterfly. It holds good for *P. pammon* as well:—The butterfly emerged at 6-55 A.M. While it was emerging the little finger of the left hand was presented and it held on to it. The wings were not crumpled but short and very soft. The legs were properly developed and were quite functional, the butterfly being able to walk quickly. The wings began to increase in size and attained the full size at 7-5 A.M. but were soft yet. They began to harden from the base. At times the butterfly tried to raise them but they bent down beyond the stiff portion. They became stiff up to the tip at 7-30 A.M. Still the butterfly was not able to fly. It was occasionally frightened by sweeping the right hand past it in order to make it fly away; it would only shift its position a little or straighten itself up. It began to unfold the wings flat and close them over the back at intervals, evidently to bring the connected muscles into play. It was not able to fly until these muscles were in proper working order. At 7-45 A.M. it flew but alighted on the ground at a distance of about five yards. A finger was presented and it was easily induced to crawl on to it. It sat on the finger and was not disturbed. It took to wing and sailed away in the air at 8-10 A.M.

The expanding and stiffening of the wings is effected by a greenish fluid which runs from the body into the veins. The decrease in size of the body is distinctly perceptible as also the swelling of the veins and their change of colour to a greenish tinge. The costal vein of the left hind wing of this butterfly was injured; a greenish fluid collected at the injured point into a small greenish gall; the vein beyond the injured point did not develop and the portion of the wing served by this vein or rather a little more became crumpled and remained so.

In confinement it is not easy to get butterflies to lay eggs. They mate easily if sufficient room is available for them to fly freely.

One female and one male *P. demoleus* emerged on the morning of 23rd April. They were liberated in a big cage at 8 A.M. and at 10 A.M. were found coupling. Both were sitting on wire-gauze side of the cage, the head of the female being downwards. They continued to sit at the same place till 11-5 A.M. when they separated and the male flew away; the female continued to sit there for some time. Similar observations were made on several pairs. They were supplied with diluted honey and had access to a living lemon plant. Several such couples reared in the Insectary, were tried but no eggs obtained. The butterflies also did not live for more than two days. On one occasion eggs were obtained from *P. pammon*.

One pair of *P. demoleus* butterflies in copulation was captured in the morning of 11th June and liberated in a big cage where they had access to a living orange plant. The male died on 12th. Between 13th and 14th the female laid twenty-one eggs, eleven on the stem, three on the upper-surfaces and seven on the undersurfaces of leaves, and died in the afternoon of 14th. The eggs hatched between 16th and 17th.

Enemies.—The eggs of both these butterflies are parasitised to a very great extent, by three kinds of minute Hymenopterous insects. Out of 245 eggs collected between 4th and 25th April, 96 or about 39% were found to be destroyed by these insects. Out of 65 caterpillars collected about the same time, only two (*P. demoleus*) were parasitised by a Tachinid fly. The caterpillars pupated with the parasites in their body and the maggots came out of the pupæ, four from one and six from the other, and pupated outside. In nature they drop on to the ground and pupate there. The majority of the caterpillars were collected before they passed through the fourth moult, *i.e.*, before they became green, and many of the eggs too were collected in

the early stage. It is possible that some more might have been parasitised if left in the natural conditions.

Further details in the life-history of each are given below :—

Papilio demoleus.

Life-cycle :

Egg collected.	Larva hatched.	Larva pupated.	Butterfly emerged.	Duration in days.
11th December	19th December	15th January	7th March	8 + 27 + 52 = 87
"	"	28th "	24th "	8 + 40 + 56 = 104
22nd April	25th April	10th May	19th May	3 + 15 + 9 = 27
3rd July	5th July	16th July	24th July	3 + 11 + 8 = 22

Larval moults :

Larva hatched.	1st moult.	2nd moult.	3rd moult.	4th moult.	5th moult.
4th April	7th April	9th April	11th April	13th April	17th April, pupated.
25th "	27th "	29th "	1st May	5th May	10th May, "
5th July	7th July	9th July	11th July	16th July, pupated.	

The following is the record of the growth of a larva which hatched on 4th April :—

4th April 1913: Young larva.— $2\frac{1}{2}$ mm. long when fully stretched in locomotion. Not exactly but about cylindrical in shape. Head smaller than thorax which is the thickest part; body becomes very gradually narrower towards middle of abdomen and again somewhat thicker towards the anal segments. Head and prothorax brownish-yellow; dorsal regions of third and fourth and to a less extent of the fifth abdominal segments yellowish-white; abdominal segment eighth and the first anal segment brownish-yellow; rest of body brown or dark brown.

All segments except the head and second anal segment are provided with small spines; hence the larva looks spiny. Each spine consists of a small fleshy tapering protuberance, surmounted by a white hair but black at the

tip and having in addition hairs on the sides. The arrangement of the spines on each side is as follows :—

	Pro-thorax.	Meso-thorax.	Meta-thorax.	ABDOMINAL SEGMENTS.								ANAL SEGMENTS.	
				1st	2nd	3rd	4th	5th	6th	7th	8th	1st	2nd
Sub-median ..	1	1	1	1	1	1	1	1	1	1	1	1	1
Dorso-lateral ..	1	1	1										
Supra-spiracular ..				1	1	1	1	1	1	1	1	1	
Spiracular ..	1	1	1										
Infra-spiracular ..	1	1	1	1	1	1	1	1	1	1	1	1	

The sub-median spines are situated in the sub-dorsal line on the edge of the median region; those on the second anal segment are merely small tubercles surmounted with hairs. The dorso-lateral spines are situated just below the sub-median spines; those on prothorax are the biggest of all the spines on the body. The supra-spiracular spines are situated just above the line of spiracles; those on first abdominal segment are of the form of real spines, the others being practically rosettes of hairs. The spiracular spines are in a line with the spiracles; those on meso-thorax and meta-thorax are like tubercles surmounted with hairs. In the infra-spiracular position, *i.e.*, below the spiracles, the segments have really small rosette-shaped tufts of hairs.

The spines are of the same colour as the segments; but the spines on third and fourth abdominal segments are white, like their dorsal regions.

6th April.—It seems the larva is going to moult. Two faint whitish interrupted stripes are visible under the lens below the sub-median row of spines on each side.

7th April: 1st moult.—The larva is about 4 mm. long, the appearance is as spiny as before, the same spines being there, only the spiracular spines on meso-thorax and meta-thorax have become shorter and blunt. The shape too is about the same, the thoracic region being thicker than the rest of the body. The head is brown with a faint white patch above the clypeus. The prothorax is brownish-yellow with the spines. Only the dorsal regions of the eighth abdominal and first anal segments are brownish-yellow with the spines on them. The white patch on third, fourth and fifth abdominal segments is prominent; laterally it is found to have encroached a little on the second abdominal segment. The general colour is brown as before but a little darker. Two faint interrupted whitish stripes are found below the sub-median row of spines on each side.

9th April : 2nd moult.—The larva is about 7 mm. long. There is not much change in appearance. The head is about as big or slightly bigger than the prothorax, dark brown in colour and has a whitish spot above the clypeus with yellowish markings round it. The pronotum with the spines on it is brownish-yellow and has developed some white markings which are interruptedly continued in the lateral region on to the meso-thorax. White markings connected with the white patch on third, fourth and fifth abdominal segments, extend on to the second abdominal segment on each side. White markings have appeared on the eighth abdominal segment below the spines. The stripes below the sub-median spines have become fainter. Short tubercles in the form of smaller spines have appeared one on each side of the median line on the three thoracic and the first abdominal segments and also in place of supra-spiracular rosettes on seventh and eighth abdominal segments. The spiracular spines on meso-thorax and meta-thorax have become still smaller. The spines are of the same colour as the segments, those on third and fourth abdominal segments being white as before; the spiracular spine on prothorax is white.

10th April.—The larva has grown rapidly from 7 mm. to 11 mm. in the past 24 hours. The region about the meta-thorax and first abdominal segment is the thickest part being about 3 mm. in diameter, from which the body tapers on either side; the hind part is about 2 mm. or a little less in diameter.

11th April : 3rd moult.—It has grown to about 12 mm. in length, but has undergone hardly any change in shape. The general colour is black. The prothoracic dorso-lateral spines which look like horns, have become thicker and bigger. On each side of the median line tubercles are found in all spine-bearing segments except third to sixth abdominal segments; those on prothorax are reduced so much in size as to be practically non-existent; those on the meta-thorax are the biggest. The white markings on prothorax have extended in the spiracular regions up to meta-thorax, the spiracular spines on all these segments being white. The white patch in the middle of the body extends in the dorsal region either interruptedly or in varying breadth from second to seventh abdominal segments and on each side from second to fourth abdominal segments. There is a prominent white patch on each side on seventh, eighth and first anal segments, speckled with black. The spines are brown except the thoracic spiracular ones, as already noted, those on third and fourth abdominal segments and the supra-spiracular ones on eighth abdominal and first anal segments.

12th April.—The general colour is a very dark grey.

13th April : 4th moult.—The larva has undergone a complete change in appearance and colour. It has grown to about 23 mm. in length. The meta-thoracic region which is the thickest part measures about 6 mm. across and the hind part of the body about $4\frac{1}{2}$ mm. across. Head dull yellowish-brown, together

with legs and prolegs. All spines have disappeared except the prothoracic dorso-lateral ones which look like a pair of horns and the sub-median ones on first anal segment; these too have become much shorter and hairless and are brown in colour. The head is deflexed and is not visible when looked at from a posterior direction. The anterior part of prothorax has an edging of grey which is marked with thin black markings and continues up to the meso-thorax above the region of the legs. The meta-thorax and the first abdominal segments have united and merged into apparently one segment bordered on the anterior edge by interrupted brown which is preceded by a broad grey band and on the posterior edge by a brown band which is followed by black in the anterior part of the second abdominal segment; this black band usually remains telescoped under the preceding segment and thus hidden under the brown band. Throughout the length of the body there is a whitish stripe just above the bases of the legs; continuous with this stripe there is a brown broad marking on the fourth abdominal segment running obliquely upward on to the fifth abdominal segment; there is a similar somewhat oblique marking or patch in the spiracular region on the sixth abdominal segment. The anterior parts of abdominal segments third to seventh, have black spots which are not, however, usually visible as these parts remain telescoped under the preceding segments. In place of the sub-median spines abdominal segments fifth to eighth have very small brown or yellow tubercles or rather spots. The posterior part of the first anal segment is dark grey. Above the prolegs, the second anal segment has a black lunar marking. General colour yellowish-green. Ventrally whitish.

14th April.—This morning the colour has become green.

15th April.—About 40 mm. when extended in motion; about 7 mm. across meta-thorax, and about 5 mm. across abdomen. From the meta-thorax the body is very slightly and gradually tapering posteriorly. Anteriorly too, it tapers rather abruptly. Colour green. Spots on seventh and eighth abdominal segments have practically disappeared.

16th April.—Began to rest before pupating.

17th April.—Pupated. Colour of head, thorax and wing regions of pupa very light green; of rest of body light yellow.

18th April.—The pupa is dry straw colour.

25th April.—Male butterfly emerged.

The larvæ in the last instar show a great variation in colour and appearance. This, however, is not indicative of sex. This has been proved by rearing a large number of the larvæ separately. The majority correspond to the description given above

which may be taken as that of the typical larva in the last instar. In addition the following variations were noticed:—

(1) In some the spines on the seventh and eighth abdominal segments do not disappear: the other spines disappear as described above, but in their places small tubercles are found.

(2) In many the general colour is slightly greenish yellow or yellow instead of being green. Before pupation however much of the yellow fades and proportionately the green is apparent. In these yellow larvæ the grey portions are prominently black.

(3) In many there is a rich suffusion of black. The thoracic segments including the anterior part of the composite segment are suffused with black or are almost black, only the spiracular regions being yellow. The anterior parts of second and third and the dorsal regions of seventh and eighth abdominal segments and almost the whole of the anal segments are suffused with black.

(4) In some the small round spots in the sub-median regions on sixth, seventh and eighth abdominal segments do not disappear. Occasionally any one of these segments may be without these spots, the others having them. These spots are either brown or partly blue and partly brown.

(5) In some, the broad oblique marking on fourth and fifth abdominal segments is broken up into (*a*) a small patch on the fourth below the spiracle and detached from the whitish stripe above the region of the legs, and (*b*) a pair of small round spots on the fifth, one in supra-spiracular and the other in the sub-median position. The marking on the sixth abdominal segment too is reduced to a small patch below the spiracle.

(6) In some again there is no marking or spot in any of the abdominal segments, the larvæ looking uniform velvety green. In fact in these larvæ the only markings present are the edgings of the composite segment and the grey bands preceding and following it.

Pupa.—The pupa is 31 mm. long by 10 mm. broad. In shape it is about the same as that of *P. pammon* described below, showing the same constrictions and protuberances, with the following points of difference :—

(1) The protuberances on the head are much smaller, being about $\frac{1}{2}$ mm. or a little more in length ; hence the indentation between them is much shallower.

(2) The prothoracic constriction is about 6 mm. across ; the mesothoracic protuberant portion is $7\frac{3}{4}$ mm. across ; the meta-thoracic constriction is about $7\frac{3}{4}$ mm. across ; the broadest part about the third abdominal segment is 10 mm. across. The meta-thoracic constriction is much less apparent than in *pammon* pupa ; hence the breadth at the third abdominal segment is not apparently so great as in *pammon* pupa, which has a much broader appearance.

Papilio pammon.

Life-cycle :

Egg laid.	Egg hatched.	Larva pupated.	Butterfly emerged.	Duration in days.
(1)	10th April	23rd April	1st May	3 + 13 + 8 = 24
(2)	27th „	14th May	23rd „	3 + 17 + 9 = 29
(3)	25th August	5th Sept.	21st Sept.	3 + 16 + 11 = 30
(4) 5th March.	12th March	12th April	22nd April	7 + 31 + 10 = 48

The eggs of (1), (2) and (3) were collected from outside. A very large number of eggs were collected at this time and the egg-stage was found to be about three days. (4) was observed in another year which was much colder.

Larval moults :

Larva hatched.	1st moult.	2nd moult.	3rd moult.	4th moult.	5th moult.
12th March	22nd March	26th March	1st April	12th April, pupated.	
23rd April	25th April	29th April	1st May	5th May	11th May, pupated.
27th „	29th „	2nd May	5th „	7th „	13th „ „
27th „	29th „	1st „	3rd „	6th „	14th „ „

The following is the record of larval development :—

10th April : *Egg hatched*.—Young larva several hours old, about 3 mm. long. Head and prothorax and meta-thorax are the thickest parts ; mesothorax is slightly thinner ; beyond the meta-thorax the body tapers slightly

becoming slightly thicker again at the anal region. The same number of spines or tubercles are present as in the *P. demoleus* larva but except those on prothorax and eighth abdominal and first anal segments, the other spines are distinctly smaller so as to be considered as minute tubercles bearing hairs; also the body is not so hairy as in the other larva but it has small tubercles on each side of median line between the sub-median spines on the three thoracic and the first abdominal segments; these develop in a later (third) instar in the other larva. *Pammon* larva has a distinctly less hairy and less spiny appearance. It differs entirely in colouration. Its general colour is yellow, with the two sides dirty brownish; thus at a casual glance its entire dorsal region looks yellow. The tubercles on prothorax, fourth and eighth abdominal and first anal segments are pale yellow; those on other segments are brownish-yellow.

12th April: 1st moult.—Length about 6 mm. Across meta-thorax about $1\frac{1}{2}$ mm. Across hind part about 1 mm. Head brown with blackish markings, smaller than prothorax. Segments not clearly distinguishable, specially meso-thorax and meta-thorax and the first abdominal segment. All spines except the horn-looking prothoracic dorso-lateral ones and those on seventh and eighth abdominal and first anal segments have become reduced in size and seem to be very small tubercles only. General colour yellow with the sides darker. There are somewhat indistinct broad white markings on the sides of third abdominal segment which go up posteriorly and seem to unite or approach on the back of the next segment. The sides of seventh and eighth abdominal segments and anterior part of first anal segment are white.

14th April: 2nd moult.—The larva measures 9 mm. in length, across meta-thorax about 2 mm., and across abdomen about $1\frac{1}{4}$ mm. There is not much change in appearance. Head and prothorax yellow. General colour of rest of body dull dark brown. The whites on the sides of third abdominal segment have become more prominent and have extended to the posterior part of the preceding segment and approach each other on the back of the succeeding segment. In continuation of this white patch, the dorsal region of the succeeding segments up to the seventh abdominal is yellow. The sides of seventh abdominal segment white with a brown spot; sides and dorsal region (where there is a brown spot) of eighth abdominal segment white with the spines; anterior region of first anal segment white.

16th April: 3rd moult.—Length about 19 mm. Breadth about $4\frac{1}{2}$ mm. across meta-thoracic segment which is the thickest part from which the body tapers both ways; about 3 mm. across middle of abdomen and again thicker about eighth abdominal segment which measures about $3\frac{1}{2}$ mm. across. General colour dark brown. Head brown, shiny, with whitish markings on

sides, deflexed and not visible when looked at from the direction of the back. Prothorax brownish-yellow with the horns yellow; from the base of the horns a broad white stripe in the spiracular region up to meta-thorax. Broad white markings from about the spiracular regions of the second abdominal segment, going obliquely upwards over the third abdominal, coalesce on the back of the fourth abdominal segment and extend up to the back of the fifth abdominal segment. Above the spiracle, the posterior $\frac{3}{4}$ of the sides of seventh and whole sides of eighth abdominal segment white, as also the anterior part of first anal segment in continuation. No other proper spine except the prothoracic horn-like dorso-lateral and the sub-median ones on eighth abdominal and first anal segments, the other spines are reduced to tubercles small or big; those on third and fourth abdominal segments are reduced to a very minute size.

18th April: 4th moult.—Larva moulted at 10 A.M. About $5\frac{1}{2}$ mm. across the composite segment formed by the union of meta-thorax and first abdominal segment, which is the thickest part from which the body tapers slightly and gradually towards the hind end and more towards the head. In general appearance the larva resembles the *P. demoleus* larva in this stage. Head dull dirty green with a slightly yellowish tinge. Colour of body green, ventrally greenish white, like green covered with a white powder. Behind the head the anterior part of prothorax has a brownish marking which is continuous with the big broad velvety dark brown patch above the legs; these velvety brown patches from each side meet each other over the back at the posterior part of the composite segment where it is bordered anteriorly by a brown collar. The anterior edge of the composite segment has a somewhat raised ridge looking like a collar which has black markings on it. In this larva this collar goes down about as far as the supra-spiracular area on each side and does not meet the velvety brown patch. (In the *P. demoleus* larvæ this collar meets the patches, which are either brown or dark or black, on each side). From the second abdominal up to the anal segments there is a fleshy fold which is white and looks like a stripe just above the base of the prolegs. In continuation with this stripe or a little detached from it, a broad brown marking on the fourth abdominal segment goes obliquely upwards up to the posterior part of the sub-median region of the fifth abdominal segment. There is a similar marking or patch on the sixth abdominal segment only up to the spiracular region; some larvæ do not show this marking. The posterior corner of the lateral region of the eighth abdominal segment, the whole of the lateral and posterior part of first anal and the entire anal segment, are whitish with numerous black patches.

The prothoracic horns are much reduced in size and only look like wedge-shaped protuberances and are yellow in colour. The spines on eighth

abdominal segment are very much reduced in size and are like minute tubercles; those on the first anal segment are also reduced but still look like spines or cerci. There is no other spine or tubercle on the body. On fifth abdominal segment two small round blue spots with brown rim are present but included in the oblique brown patch, one in sub-median and the other in supra-spiracular region. There is a pair of similar spots in the sub-median region of sixth abdominal segment. The dark-brown velvety space above the thoracic legs is quite large and is a distinguishing character.

20th April.—Length 40 mm., 10 mm. across composite segment; 6 mm. across sixth abdominal segment, $4\frac{1}{2}$ mm. across prothorax. Head brownish yellow, about 4 mm. from side to side. Colour of body green. Anterior edge of prothorax grey-brown. The region of the horns forms a raised rim, yellow in colour. The velvety space above the legs, on meso-thorax and composite segment is grey-brown. This grey-brown patch on either side goes upwards and meets on the back at the posterior part of composite segment followed by black in the anterior part of second abdominal segment; this black may ordinarily remain telescoped under the composite segment and be invisible. The anterior part of no other segment shows black markings or spots. The other markings on the body are there as described after fourth moult. The tubercles on seventh and eighth abdominal segments have completely disappeared.

21st April.—Length 45 mm. when extended in locomotion; across composite segment $11\frac{1}{2}$ mm.; across prothorax 5 mm.; across anal segment 6 mm. The *P. demoleus* larvæ, too, attain to this size but the composite segment (meta-thorax and first abdominal segment) is a little less broad being about 9 mm. or $9\frac{1}{2}$ mm. across. Hence, the anterior end of *P. pammon* larva in the full-grown state looks more tapering. At each extremity of the yellow collar on anterior edge of composite segment there is a big black ocellated spot looking like an eye.

22nd April.—Larva pupating.

23rd April.—Pupa.

The pupa.—The pupa measures 31 mm. \times 12 mm. The shape is peculiar or which a reference should be made to the illustration. The head has a pair of protuberances one on each side, about 2 mm. long, the median region being deeply indented. The prothoracic region is somewhat constricted (6 mm. across). The anterior part of meso-thorax is thicker (8 mm. across), shows a protuberance on each side laterally and a third somewhat pyramidal one in the median region. The meta-thoracic region is again constricted (7 mm. across); then the body becomes broader, being broadest at the third abdominal segment measuring 12 mm. across and then tapers towards the hind end which measures about 2 mm. across. The measurements of all

pupæ of both *demoleus* and *pammon* are taken from the direction of the back ; the length is measured from the indentation on the head to the hind end and the breadth across the broadest part, viz., the third abdominal segment.

In colour the pupæ are green. Some pupæ may be of a mottled colour ; the general colour is light bluish-green with a suffusion of grey, wood-brown and small patches of black here and there. The green pupæ have a brown spot in each sub-median region on meta-thorax. The motley pupa has a tubercle in each sub-median region on abdominal segments fourth, fifth and sixth. The girdle of all pupæ (*demoleus* and *pammon*) passes over the meta-thorax. The parts of the pupa are rigid and not capable of any kind of movement except the three inter-segmental regions between the fourth and seventh abdominal segments, which allow of movements in all directions. Usually when the pupa is disturbed it moves these segments laterally and a short hissing sound is produced. The *P. demoleus* pupa too produces a similar sound but much less distinct.

1st May.—Butterfly emerged, male.

PAPILIO ARISTOLOCHIE, FABR.

(Plate V, figs. 1—6).

[Bingham, Fauna of India, Butterflies, Vol. II, 1907, p. 20.]

Distribution.—North-West India, Sikkim; West and South India, Ceylon, Assam, Burma, Tenasserim, extending on the east to China and Siam and southwards to Malacca, Java and the Philippines. (Bingham).

Food.—The spiny velvety black caterpillars of this butterfly are usually found feeding on the leaves of the climbing herb, *Aristolochia indica*, Linn. They probably feed on all species of *Aristolochia*. In October 1901 they were reported from Surat Farm as feeding on Kodu plants (*Lagenaria vulgaris*, Ser.). In July 1905 they were reported to be found on *Luffa aegyptiaca*, Mill. at Darbhanga. In the Insectary however they did feed on either of these plants. In the neighbourhood of Pusa they have never been found on any other food-plant except *Aristolochia indica*. The larvæ eat leaves and also green fruits if leaves run short.

Broods.—The butterfly hibernates in the pupal state. Frequently the hibernation is continuous with a further period of æstivation. In August and September 1906 large numbers of caterpillars and eggs were collected. They are found in numbers from June to September every year. Below is shown the behaviour of some of the pupæ which explains the hibernation and æstivation.

Larva pupated.	Butterfly emerged.	Duration of the pupal stage in days.
15th September 1906	30th March 1907	196
15th 	15th July 1907	303
16th 	29th September 1906	13

Larva pupated.	Butterfly emerged.	Duration of the pupal stage in days.
17th September 1906	29th September 1906	12
17th " "	30th " "	13
17th " "	3rd October "	16
17th " "	12th May 1907	237
18th " "	7th October 1906	19
18th " "	28th April 1907	222
19th " "	24th " "	217
19th " "	25th May "	248
10th August 1913	20th August 1913	10

Ordinarily the period of the life-cycle is about a month and a half. In the Insectary the latest butterfly before winter emerged on the 7th October and the first after winter on the 30th March. Thus it is evident that the insect may have only one generation or up to four or five generations at the most in the year, as sometimes breeding is continued far into the period of hibernation.

The egg. (Pl. V, figs. 1 & 2).—The egg is round and $1\frac{1}{2}$ mm. in diameter. Actually the egg-shell is smooth and like a thick dirty white membrane. But the appearance of the egg is red on account of the red contents and it is covered with a thick coating of a resinous substance. This coating is not smooth but is shallow at places, presenting broad and more or less regular furrows extending from a place at the top of the egg down the sides. The broad ridges are not uniform and continuous but consist of a number of yellow shining protuberant lumps of the same resinous substance. The egg is gummed on the surface of the leaf with this substance, a quantity of which is found collected under the egg so as to form a sort of a disc-shaped seat for it.

The eggs are deposited singly on the leaves, usually on their undersurfaces. In the Insectary no eggs were obtained from the butterflies. Eggs were collected from outside and from what has

The sub-infra-spiracular tubercles are very small. On the second anal, *i.e.*, the last segment, there are two small tubercles in the sub-median position and similar tubercles on the ventral surface of the second abdominal segment just below the sub-infra-spiracular spines. Towards the end of the first stage and before the first moult, whitish spots appear round the prothoracic shield, *viz.*, a pair in front, a pair behind, and one beyond each extremity near the base of the spiracular spines; the sub-median spines and the tips of the infra-spiracular spines on the third abdominal segment become yellowish white.

After the first moult the resemblance with the grown-up larva becomes practically complete, except for the yellowish band which appears after the second moult and gradually becomes broader in successive stages. After the first moult the sub-median and infra-spiracular spines on the third abdominal segment are yellowish white, all the tubercles and spines lose the hairs, and all tubercles develop into short spines; the sub-median spines on prothorax and second anal segment found in the grown-up larva appear as small tubercles and gradually grow bigger.

Throughout the larval stage the caterpillar retains a general similarity of appearance. The colour changes from dark red to a velvety drab, *i.e.*, black with a reddish tinge. The full-grown larva (Pl. V, fig. 3) is about $2\frac{1}{2}$ inches long and about $\frac{1}{2}$ inch wide. It is cylindrical in shape and tapers slightly towards both ends. The head is dull black, the \wedge -shaped marking on it being red. The prothoracic shield is of the same colour as the head. The colour is uniform velvety drab, there being only a yellowish white band on the third abdominal segment extending to the infra-spiracular spine on each side. All the spines are beautifully red in colour except the four situated on this band which are of the same colour as the band. The yellowish white spots which appeared round the prothoracic shield in the first stage are red and appear like small tubercles, the pair behind the shield are big and may be considered

as spines. The spines on the grown-up larva on each side are as follows :—

	Pro-thorax.	Meso-thorax.	Meta-thorax.	ABDOMINAL SEGMENTS										ANAL SEGMENTS	
				1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Sub-median	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Supra-spiracular		1	1												
Spiracular	1														
Infra-spiracular	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sub-infra-spiracular	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ventral				1											

When the larva is disturbed or the wind blows against its body, it throws out from under the pair of red spots on the anterior part of the prothorax, a pair of very soft yellow processes like those of *Papilio pammon* and *P. demoleus*, but without the smell characteristic of them. In the case of *P. aristolochia* there is a faint smell like that of the fruits of its food-plant.

The caterpillar passes through five or six moults. In all the moults except the last at which pupation takes place, the moult of the head is cast separately. Before commencing the rest for moulting, the larva prepares a very thin silken padding on the surface of the leaf and entangles the hooks on the prolegs in its fibres. It walks a little forward when the skin is being slipped off posteriorly, rests a little and then turns round and eats the cast skin.

Hatched.	1st moult.	2nd moult.	3rd moult.	4th moult.	5th moult.	6th moult.	Duration of larval stage in days.
21st Sep. 1906 ..	26th Sep.	30th Sep.	8th Oct.	18th Oct.	25th Oct.	30th Nov. pupated	49
12th June 1913 ..	15th June	18th June	20th June	23rd June	30th June, pupated		18

The larval stage of the first caterpillar is seen to last for forty-nine days. But it was noticed that some time before this larva hatched many had commenced hibernation in the pupal state. Hence its larval stage had to be passed in the hibernating period and was consequently prolonged.

The pupa (Pl. V, figs. 4 & 5).—When about to pupate the larva forms the usual silken padding. Pupation takes place on the food-plant or on the tree which forms the support of the food-plant, it being a climbing creeper. In the Insectary it took place on the wire-gauze of the cage. The hind or anal prolegs are entangled in the silken padding and a silken girdle across the meta-thoracic region holds the larva in position. Thus secured it rests before pupation with its head upwards. It voids a quantity of loose excreta before commencing the rest. After a rest of one to two days or more according to temperature, the larval skin is cast off and the pupa emerges. The pupa too is secured at the hind end and by the girdle. The pupa is brown and of a peculiar shape with flattened protuberances on head, thorax and abdominal segments, looking like a small conch-shell or a crumpled dry leaf. The pupal stage has been shown while discussing broods.

The imago.—The pupa develops a black tinge before the emergence of the imago. The butterfly comes out by bursting the suture between the head and prothorax of the pupa, the fissure extending along the antennæ up to about the end of the wing-case. At the same time there is another cleavage on the back running along the middle of prothorax and meso-thorax and then sideways to a certain extent. As the butterfly struggles out it voids a quantity of pink coloured liquid excreta in the pupa-case. After emergence it hangs on the deserted pupa-case until the wings develop and all the limbs harden. None of the butterflies bred in the Insectary lived for more than four days.

PLATE VIII.



THE TUR HAIRSTREAK.

CATOCHRYSOPS CNEJUS, FABR.

THE TUR HAIRSTREAK.

(Pl. VIII).

[Bingham, Fauna of India, Butterflies, Vol. II, 1907, p. 415.]

Systematic position.—The butterfly, *C. cnejus*, belongs to the sub-family Lycæninæ of Family Lycænidæ.

Under this genus De Niceville lists nine species but he recognises only three and states the other six to be only the variable forms of these three species. (Butterflies, Vol. III, p. 176). Bingham agrees with him and adopts the same classification in the Fauna of India (Butterflies, Vol. II, pp. 415-416).

Distribution.—Throughout our limits except at very high elevations. Widely distributed in the Malayan sub-region; extending to Australia and the Southern Islands. (Bingham).

Occurrence.—At Pusa *Catochrysops cnejus* has been reared from egg, larva or pupa stage in February, April, May, June, July, September and October. It has been similarly reared by Mr. Ratiram Khamparia at Nagpur, Central Provinces, in May, November and December. It is thus found to be active throughout the year.

Food-plants and damage.—De Niceville bred the butterfly on *Phaseolus trilobus*, Linn. In Orissa it is reported to feed on *Dolichos catjang*, Roxb. At Pusa it has been reared on *arhar* (*Gajanus indicus*), *mung* (*Phaseolus radiatus*), *barbati* (*Dolichos catjang*), *barasim* (*Canavalia ensiformis*), *moth* (*Phaseolus acontifolius*).

At Nagpur it has been reared on *mung*, *arhar* and *barbati*. The larva feeds on flower buds or beans and will probably feed on any leguminous plant of a similar nature.

As regards the amount of actual damage, *C. cnejus* may very well be classed with the two known pests of the same family (Lycænidæ), viz., *Virachola isocrates*, Fabr., known as the Anar caterpillar, which attacks pomegranate (Indian Museum Notes, Vol. I, p. 193, and Indian Insect Pests, p.179), and *Lampides elpis*, Godart, which attacks cardamom in Ceylon and Southern India (Indian Museum Notes, Vol. I, p. 11). In the case of *C. cnejus* the damage is not so apparent on account of the nature of the food-plant. The crops, which afford food to this insect, are usually cultivated on a very large scale and they usually put forth such a profusion of flowers and fruits that the damage caused by it, although it may be considerable, appears small and is not so much noticed. In one year in the spring as many as seven out of twenty flowers collected at random were found to be affected. Again a small plot of *mung* in the Insectary compound was so badly attacked in July that there could hardly be found a single pod unaffected.

Life-history.—The life-cycle of *C. cnejus* is shown in the table below. Its duration varies somewhat according to temperature :—

Egg laid.	Egg hatched.	Larva pupated	Butterfly emerged.	Duration in days.
	28th Feb.	18th March	29th March	18 + 11
		20th ..	30th ..	20 + 10
6th March	13th March	27th ..	5th April	7 + 14 + 9 = 30
6th ..	13th ..	29th ..	7th ..	7 + 16 + 9 = 32
21st June	24th June	4th July	10th July	3 + 10 + 6 = 19

The Egg.—The egg is exactly round, flat and disc-shaped ; about .6 mm. in diameter and about .25 mm. thick ; white with a bluish tinge. On the upper surface of the egg there is a black or dark spot which is the centre of a slight depression or concavity in the middle. The surface is roughened with numerous regularly arranged raised points.

Eggs are usually laid singly on flowers, flower-buds and pods, sometimes on leaves and stems and rarely on other plants growing in the midst of and contiguous to the food-plant. One butterfly

while depositing eggs on *mung*, deposited one egg on the blade of a grass growing among the *mung* plants. The butterfly flits about the whole day, flying quickly here and there, sits for a moment on a plant, bends the abdomen, touches the surface with the tip of its abdomen, deposits the egg and soon flies away again. Before hatching the colour of the egg turns a little dark in the middle of the disc. The larva hatches by gnawing the middle portion of the upper surface of the shell but does not eat the egg-shell after emergence. The empty egg-shells are white and stick to the plant with a gaping hole at the top.

The larva.—The young larva is about $1\frac{1}{4}$ mm. long, flattened, the margins of the body being practically parallel. In shape it resembles the grown larva, only the head is comparatively large, being about equal in breadth to the body. The head is black and shiny. The prothorax bears a black shield which looks like a big black spot at the middle of the pronotum. The colour is slightly greenish and greyish pale yellow, with a faint yellowish-brown stripe along each sub-median region on the back. The thoracic and the first six abdominal segments are distinguishable as in the adult larva. The seventh, eighth and ninth abdominal segments merge into each other and are not distinguishable unless looked at from the ventral side. The thoracic legs and five pairs of prolegs are quite clearly seen. The whole body is covered with somewhat longish hairs. The larvæ grow without any remarkable change in shape but show a variation in colour. From the beginning some are green while others are reddish brick colour. The green larvæ hardly undergo any change in colour. The ventral surface of the reddish larvæ is green and they may retain the reddish colour of the back till some time before pupation or may gradually become green by about the middle of the larval life retaining only a brownish mid-dorsal stripe and a very few faint oblique markings of the same colour on each side of the back.

A full-grown green larva measures about 16 mm. long by about 4.5 mm. across the body, is flattened, the margins of the

body being almost parallel, only the thoracic region tapering anteriorly. The back is convex and the ventral surface is flat. The margin of the hind end is rounded and so is that of the prothorax. The head is black, shiny and small and usually remains hidden under the prothorax. All the segments of the body up to the sixth abdominal are more or less distinct. Then the remaining segments merge into each other. The colour is uniform green, the dorsal vessel showing as a darker mid-dorsal stripe; and in addition there are, on each side of back, very faint oblique whitish markings. The legs and prolegs are also green. A full-grown reddish brown larva measures about the same. Its pronotum is entirely reddish-brown. Meso-thorax and meta-thorax are almost similarly coloured but the sub-median regions of these segments are paler. The mid-dorsal region of the remainder of the body is reddish-brown and also the margins. There are oblique greyish markings on the sides. On account of the reddish-brown colouring the larva looks different from an ordinary green one. Before pupation the colour changes to that of the green larva, the brown portions becoming faint. The spiracles appear as small round brown spots; the prothoracic and the first six abdominal pairs are situated laterally near the margins of the body; but the seventh abdominal pair (fig. 1) is situated on the dorsal surface, one on each side of the secreting gland; the eighth abdominal pair is also situated on the back and near the mid-dorsal region.

The larvæ secrete silk throughout the larval stage, and if they are disturbed much and have to let go their hold on the plant, they hang down by means of this silk. Not infrequently a larva may be found hanging in the air and sometimes with an ant on its back.

As has been said above, the eggs are laid on very tender flower buds generally when the corolla is yet enclosed within the calyx. The bud grows by the time the eggs hatch and the young larva bores a hole in the corolla, enters the interior of the flower and eats the stamens and the pistil. The flower generally shows no external signs of injury, the hole made in the corolla being very small. The larva has grown considerably by the time the stamens and the

pistil are consumed. It comes out by eating a portion of the corolla, continues destroying the flowers for some time and then attacks the pods. A hole is made in the pod, the body is thrust half-way in and the seed opposite to the hole is eaten. Separate holes are usually made by a grown-up larva to get at the seeds. The younger larva enters the pod bodily and eats one seed after another. The larval moults are shown below :—

Hatched.	1st moult.	2nd moult.	3rd moult.	4th moult.
24th June 13th March	27th June 17th March	29th June 21st March	1st July 25th March	4th July (perished) 29th March (perished)

Ants and the larva.—The larvæ are attended by two kinds of ants; one is the big black one (*Camponotus compressus*, Fabr.) which has been found to follow them both at Pusa and at Calcutta, and the other is a small brown one (*Tapinoma melanocephalum*). They are attended by either of the two kinds but never by both at the same time. There may be three or four or more ants attending

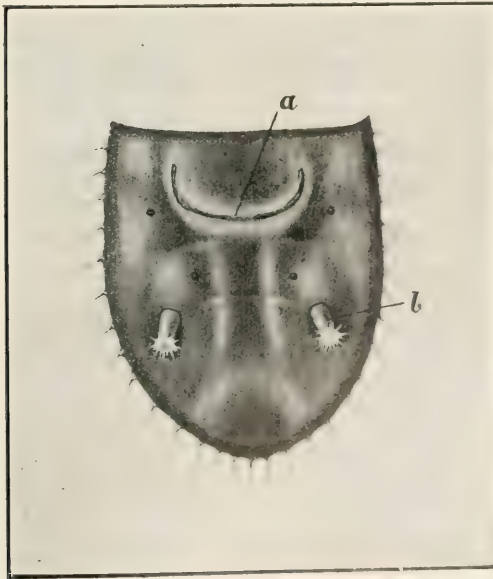


Fig. 1. Hind part of the larva of *C. erisus* showing *a*, aperture of secreting gland, and *b*, the eversible process.

one larva. The actions of the big black ants (*Camponotus compressus*) are more easily observable. The ants gently stroke the back of the larva with their antennæ and sometimes continue to do so while sitting on the back of the larva while it moves along. The ants are very quick in movement and continue to run hither and thither, seldom going far away from the larva, although

the larva may be moving about and always returning to it and stroking it with their antennæ. The ants are attracted by a white, almost tasteless and very slightly viscous liquid exuded from an aperture on the back of the seventh abdominal segment (Fig. 1, a). The ants come and lick it up. If it is not removed for some time, the liquid collects as a clear drop of watery looking fluid. The aperture is crescent-shaped, the projections or arms of the crescent being turned anteriorly. The liquid is exuded from the middle of the crescent and the ants also come and feel this part with their mouth-parts to see whether any liquid has collected. The aperture is capable of being opened and closed at the will of the larva. At times, usually when an ant is licking the middle of the crescent, a small yellow process is protruded from each arm of the crescent, the head of the process bearing a number of small radially arranged hair-like projections. These processes are thrown out only occasionally and are soon retracted. Their function does not seem to be at all clear.

From a place almost exactly on the junction of the eighth and ninth abdominal segments and much towards the margin on each side of the body is a process (Fig. 1, b) capable of being protruded and retracted. It is about $\frac{1}{2}$ mm. in length, cylindrical rod-shaped with a rounded head which bears a number of hair-like projections arranged radially. In colour it is more or less transparent dirty white and so also are the hair-like projections. These two processes are thrust out frequently, especially when the ants move away from the larva. From a distance each looks like a drop of water standing out in relief. Either both or one may be protruded at the same time. Sometimes they are retracted and thrown out so quickly that a rapid flickering effect is produced or at times may be only about half everted. They are in small cavities and when completely retracted a round spot is noticeable in their place paler than the surrounding regions. These two processes seem to serve as a means for attracting the ants from a distance. The larva does not seem to be very much affected by the overtures of the ants ; it feeds or walks about almost indifferently although the ant may

be sitting on its back, or stroking it with its antennae or licking the aperture of the secreting gland.

Pupa.—The larva before pupating applies some silk in the form of a thin layer on to the pod or on to the stem and sits with its feet entangled in the fibres. A girdle of silk is also passed round the body at about the first abdominal segment and the ends of the girdle are fixed to the surface of the pod or stem on each side. The skin is then cast off and the larva pupates.

The pupa is about 10 mm. long and measures about $3\frac{1}{2}$ mm. across the abdomen and about $2\frac{1}{2}$ mm. across the thorax. The region between the thorax and abdomen is somewhat constricted. The colour is green at first but changes to a dirty brown with black speckles. The pupa lies on its ventral surface and is held in position by the girdle. It is also held at the hind end by means of a number of short curved-tipped hairs which are entangled in the fibres of the silken pad. The attendant ants, which were confined with the larva, were found clustered round the newly-formed pupa; but the pupa was not observed to secrete anything and was eventually deserted. The pupal stages are shown in the statement of life-cycle; others are:—

Pupated.	Butterfly emerged.	Durations in days.
24th March	2nd April	9
14th April	21st "	7
29th June	4th July	6
4th July	10th "	6
28th November	15th December	17

The butterflies.—The butterflies are quick-flying, restless creatures and rarely rest anywhere for any length of time. They may rest for a few seconds and then fly away, fluttering about and may traverse several yards before settling again. When they sit the wings are usually held folded up above the back; but they are sometimes in the habit of alternately opening and closing the wings, at the same time turning either to the right or to the left. Their flight also is a sort of fluttering, quick alternate opening and closing

of the wings, and the path they describe is neither level nor straight but is an undulating curve or zig-zag. At times two butterflies, probably the male and female together fly in such a way that it is not easy to distinguish whether one or two are in flight. Then one, probably the female, settles while the other, probably the male, still flutters about ; the female at this time may unfold the wings and bring them down flat on each side and raise the abdomen. Then suddenly she takes to flight and both go away sportively as before. This probably is their courtship. At times however the male flits away and does not return.

Enemy.—One species of the Ichneumon has been found to be parasitic on the larvæ of these butterflies. The larva pupates with the Hymenopterous grub in its body. After some days the Ichneumon fly emerges by making a hole in the pupa-case.



RICE SKIPPER.

PARNARA (CHAPRA) MATHIAS, FABR.

THE RICE SKIPPER.

PLATE IX.

Swinhoe.—Lep. Ind. Vol. X, 1915, p. 320.

Distribution.—This seems to be about the most widely distributed and generally common species in Asia, extending from Syria to the Linkin Islands and Sambawa. It occurs all over India from Kashmir to Malabar, and from Bombay to Pegu and the Malay Peninsula. In addition to the above named localities, I have it from Borneo, Bali, Japan and China; and Semper states that it is generally distributed in the Philippines. Holland also records it as *Baoris chaya* from Hainan. (Edwards).

Occurrence and food-plants.—*Chapra mathias*, Fabr., is referred to by de Niceville in Indian Museum Notes, Vol. V, p. 137, as having been found as a larva in October in Calcutta, feeding on rice leaves. The butterfly is figured in Indian Museum Notes, Vol. V, Plate IX, figure 6. He states that the larva eats other grasses also.

The student of Indian insects may be cautioned against confusing this insect with the similar form, *Suastus gremius*, Fabr., also described by de Niceville as a pest of rice from Balasore (Ind. Mus. Notes, I, p. 9). The butterflies are superficially similar, and the life-history practically the same. The most ready means of distinction lies in the markings, *Chapra mathias* having white spots on the lower surface of the hind wing, *Suastus gremius* having black ones. This is of course purely superficial, the two genera being distinct in morphological characters. The larvæ of both were reared by Davidson and Aitken in Kanara, the latter from cocoanut

palm; the larva of former is described as having a red, the latter a brown line on the head. (Journ., Bombay Nat. Hist. Soc., Vol. V, p. 371).

Parnara colaca, Mo., is stated to have fed on paddy in Saran. (Ind. Mus. Notes, Vol. III, p. 113). At Pusa this as well as *Taractrocera sagara* are found commonly with *Chapra mathias* larvæ. This last has been recently reported feeding on rice from Kidderpur, Kanara and Thana, Bombay. It was found in a caterpillar swarm at Daltonganj in Bihar along with *Spodoptera mauritia*, *Lucania* spp. and others. It occurs throughout India.

These caterpillars as well as the larvæ of *Taractrocera sagara* have fed indiscriminately on leaves of rice, maize, *juar* (*Andropogon sorghum*), *kodo* (*Paspalum scrobiculatum*), *marua* (*Eleusine coracana*) and *dub* grass (*Cynodon dactylon*). In September and October the butterflies freely laid eggs on *kodo* growing in the Insectary compound. It would appear that they have a wide range of food-plants under the natural order Graminæ. The caterpillars are in the habit of hiding themselves by folding over a leaf or bringing two or more leaves together and fastening them by means of a white silk exuded from the mouth. This is very clearly seen in the plate. They thrust the head out from this hiding-place and eat the leaves from edge inwards. It is a minor pest of rice.

Life-history.—Below are shown the periods of the life-cycle observed in the Insectary in summer and winter temperatures:—

—	Egg hatched.	Larva pupated.	Butterfly emerged.
(1) Egg laid, 18th September ..	21st Sept.	11th October	20th October.
(2) Egg collected, 25th September ..	28th „	18th „	27th „
(3) „ „ 10th November ..	13th Nov.	22nd January	21st February.

The period of the life-cycle occupies a little over a month in ordinary summer temperature. But it extends over 3½ months in winter. When the third larva pupated in January, the weather

began to get distinctly warmer. Normally the winter seems to be passed in hibernation in the larval stage. (This has also been found to be the case with *Taractrocera sagara* a larva of which hibernated from 11th October to 2nd April).

The egg.—The egg is hemispherical in shape with a perfectly flat base. The diameter at the base is about 1 mm. and the height vertically from the base to the top is about $\frac{1}{2}$ mm. The surface is smooth and the colour creamy white. Before hatching a big black spot appears at the top. This is the head of the embryo showing through the shell. Under a lens the jaws also of the embryo are visible biting at the shell. The eggs are laid singly on the upper surfaces of leaves of the food-plants.

The larva.—The newly-hatched caterpillar is about $2\frac{1}{2}$ mm. long, semi-cylindrical with a convex back and flat ventral surface. The head is much bigger in diameter than the body, being about $\frac{2}{3}$ mm. across while the body is about $\frac{1}{3}$ mm. in breadth. It is flat in front and rather triangular in shape. The colour is black shiny. Its long axis is more or less at right angles to the long axis of the body. The prothorax has a narrow black plate like a half collar on the dorsal surface. The segments of the whole body, twelve in number excluding the head, are indistinct. There are five pairs of prolegs, but the legs and prolegs are short, so that when the larva rests or walks, its ventral surface seems to touch the surface. While the larva walks it is in the habit of swaying the head from side to side. The hind segment is flattened and rounded at the posterior margin. The colour is uniform pale yellow but it soon changes and becomes green when green food is taken. The young larva hatches by gnawing a hole in the shell and then eats the deserted shell either wholly or partly.

The following is the record of the growth of a larva which hatched on the 28th September:—

1st October.—Moulted (first time). The larva is about $3\frac{1}{2}$ mm. long. The collar on prothorax is not black now but light brown. There is hardly any more change. The head is not as shiny as before.

5th October.—Moulted (second time). The larva is about 6 mm. long. The appearance is about the same. A thin white stripe is perceptible on each side of the median region and one more on each side of body; besides, a thin white line along the spiracles.

• *7th October.*—Moulted (third time). Length about 10 mm. Appearance the same as in previous instar.

11th October.—Moulted (fourth time). The larva is about 17 mm. long, $2\frac{1}{2}$ mm. across head and $2\frac{1}{4}$ mm. across body. The head is not entirely black now; a white spot has appeared above the clypeus; two white broad longitudinal stripes have appeared, one on each side, and the posterior part has become dirty green. The colour of body is slightly yellowish-green; the four white narrow stripes on the back are distinct, the spiracular one is not so distinct. As from the beginning the segments are not distinct. At each successive moult the anal segment becomes flatter, its posterior margin being completely rounded.

12th October.—Measures 23 mm. in length, growing very quickly, has grown 6 mm. in 24 hours.

14th October.—30 mm. by $3\frac{1}{2}$ mm. across middle of body; tapers slightly to hind end but more prominently to the thoracic region, the prothorax being less than 2 mm. in thickness. Colour green including that of legs and prolegs; the back looks greenish white as if covered with a white powder.

18th October.—Pupated.

25th October.—Eyes of pupa become brown.

26th October.—Colour of pupa become dark.

27th October.—Butterfly emerged.

Moult.—The larva passes through four larval moults and pupates at the fifth. The following table shows the periods of the different instars.

Larva hatched.	1st moult.	2nd moult.	3rd moult.	4th moult.	5th moult, pupated.
21st Sept. 28th „	24th Sept. 1st Oct.	27th Sept. 5th Oct.	30th Sept. 7th Oct.	3rd Oct. 11th „	11th Oct. 18th „

In all the larval moults except the last at which the larva turns into the pupa, the head moult is cast separately and entire. The skin is not slipped off posteriorly; on the other hand, the larva walks out of it and it remains sticking to the place. After some

time the larva turns round and eats it. In the last moult, the head moult sticks to the skin, the fissure liberating the pupa extends over the vertex of the head and down each side of clypeus to near the mouthparts. The skin is slipped off posteriorly and it collects as a crumpled mass at the end of the pupa.

Pupa and pupation.—The caterpillar pupates on the plant. The leafy house or case which forms the hiding-place of the larva is lined with silk thus being converted into a cocoon. Pupation takes place in this cocoon. The pupa is about 23 mm. long from end to end and measures about $4\frac{1}{2}$ mm. across the thorax. It is cylindrical in shape, tapering gradually towards hind end. The head is protruded into a tapering narrow snout about 2 mm. in length. The cremaster is a transversely flattened projection bearing a number of small circinate stiff hairs on the posterior margin. These circinate hairs remain entangled in the silken fibres of the cocoon. The colour is green; the same stripes are perceptible on the back of the pupa as are seen on the back of the larva. As the pupa advances in age the wings which are folded on the ventral surface turn paler in colour. Before the emergence of the butterfly the colour becomes dark or almost black. The pupa-case is thin, white and almost transparent. The parts of the butterfly are therefore almost clearly visible.

The butterfly emerges by bursting the pupa-case along the mid-dorsal thoracic region, the fissure extending to the base of the snout and then going sideways near or over the eyes and along the regions of the antennæ. The empty pupa-case is left inside the cocoon.

The imago.—The butterflies are in the habit of sitting with their wings folded up over the back as shown in the figures 5 & 6. The wings are sometimes held a little apart from one another. The butterfly looks like a crumpled dry leaf in this posture. It rests in this position for long periods at a time. It is a quick flier but does not remain on the wing long like other butterflies. It flies with darting movements and comes to rest on bush, tree or ground and after varying periods of rest takes to wing again.

Enemies.—The caterpillars are parasitised by several parasites, both Dipterous and Hymenopterous and are preyed upon by the Pentatomid bug, *Andrallus spinidens* which sucks the body fluid and kills the victim. Three of the parasites are shown in figures 10, 11 and 12, Pl. IX. The seed-like bodies on the leaf are the pupæ of the flies, figs. 11 and 12, Pl. IX.

The maggots come out of the body of the dead caterpillar and pupate on the leaf in this fashion. These enemies keep down the number of the caterpillars so that they can hardly increase to the extent of proving a serious pest.

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